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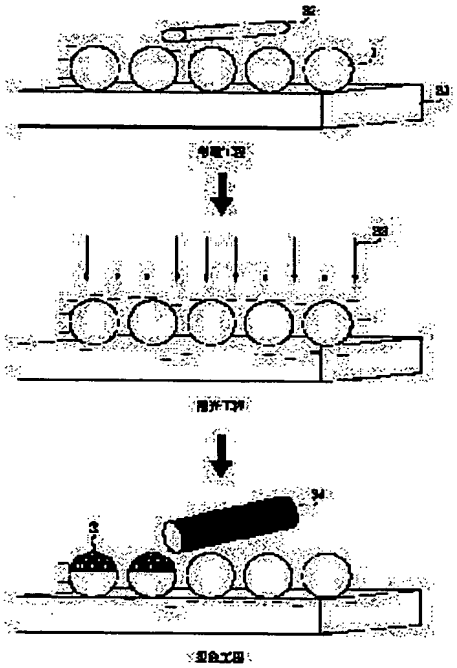
(71)Applicant : CANON INC
(72)Inventor : TOMITA YOSHINORI
YAGI TAKAYUKI
IKEDA TSUTOMU
KISHI ETSURO

(54) PRODUCTION OF COLORED BALL AND PRODUCTION OF DISPLAY DEVICE

(57)Abstract:
PROBLEM TO BE SOLVED: To make it possible to use inexpensive microballs and to reduce the cost of a display device by forming colored layers on the hemispherical surfaces on one side of the microballs by utilizing the photoconductivity.
SOLUTION: This process for producing the display device has an electrification stage for electrifying the photoconductive balls 1, an exposure stage for irradiating the partial surfaces of the conductive balls 1 in an electrification state with light, a coloring stage for forming the colored layers 2 by adhering an electrified coloring material to the bright part surfaces of the photoconductive balls 1 irradiated with the light or the dark part surfaces of the photoconductive balls 1 not irradiated with the light and a fixing stage for fixing the colored layers 2 to the surfaces of the photoconductive balls.



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(71)出願人　000001007
キヤノン株式会社
東京都大田区下丸子３丁目30番２号

(72)発明者　富田　佳紀
東京都大田区下丸子３丁目30番２号キヤノン株式会社内

(72)発明者　八木　隆行
東京都大田区下丸子３丁目30番２号キヤノン株式会社内

(72)発明者　池田　勉
東京都大田区下丸子３丁目30番２号キヤノン株式会社内

(74)代理人　弁理士　丸島　儀一

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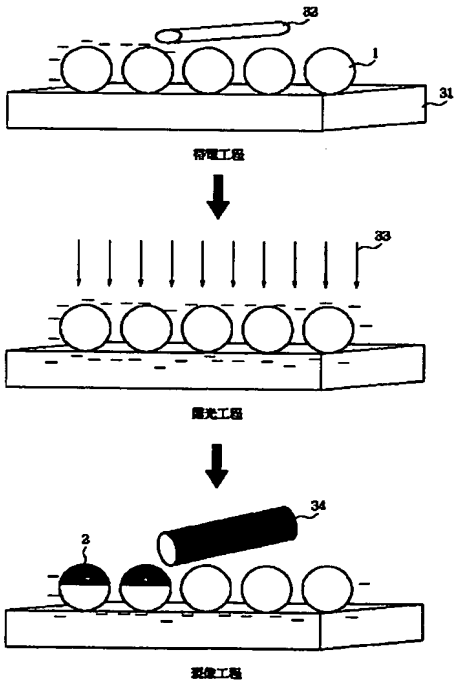
(54)【発明の名称】　着色ボールの製造方法及び表示装置の製造方法

(57)【要約】

【課題】　真空蒸着法で着色層を微小ボール表面上に作製した場合、表示装置の生産性が低いことを問題としている。

【解決手段】　本発明は、前記課題を解決するために以下の表示装置の製造方法を採用した。本発明の表示装置の製造方法は、光導電性ボールを帯電させる帯電工程と、帯電状態の光導電性ボールの一部表面に光を照射する露光工程と、光が照射された光導電性ボールの明部表面又は光が照射されない光導電性ボールの暗部表面に帯電した着色材料を付着させて着色層を形成する着色工程と、該着色層を該光導電性ボール表面に定着させる定着工程と、を有する。



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【特許請求の範囲】

【請求項１】　光導電性ボールを帯電させる帯電工程と、帯電状態の光導電性ボールの一部表面に光を照射する露光工程と、光が照射された光導電性ボールの明部表面又は光が照射されない光導電性ボールの暗部表面に帯電した着色材料を付着させて着色層を形成する着色工程と、該着色層を該光導電性ボール表面に定着させる定着工程と、を有することを特徴とする着色ボールの製造方法。

【請求項２】　前記光導電性ボールが酸化亜鉛を有する請求項１に記載の着色ボールの製造方法。

【請求項３】　光学的特性の異なる２つの表面を備えた着色ボールを回転させることにより表示を行う表示装置の製造方法において、

光導電性ボールを光透過シートに分散させる工程と、該光導電性ボールを帯電させる帯電工程と、帯電状態の光導電性ボールの一部表面に光を照射する露光工程と、着色材料を有する誘電液体に浸して光が照射された光導電性ボールの明部表面又は光が照射されない光導電性ボールの暗部表面に帯電した着色材料を付着させて着色層を形成する着色工程と、該着色層を該光導電性ボール表面に定着させる定着工程と、該着色層が形成されたボールを表示媒体内に分散させる工程と、該表示媒体表面上に電極を形成する工程と、を有することを特徴とする表示装置の製造方法。

【請求項４】　前記光導電性ボールが酸化亜鉛を有する請求項３に記載の表示装置の製造方法。

【請求項５】　光学的特性の異なる２つの表面を備えた着色ボールを回転させることにより表示を行う表示装置の製造方法において、

複数の光導電性ボールを光透過シートに分散させる工程と、該複数の光導電性ボールを帯電させる帯電工程と、該複数の光導電性ボールの中の幾つかの光導電性ボールをマスクで選択する工程と、選択された光導電性ボールの一部表面に光を照射する露光工程と、着色材料を有する絶縁性液体に浸して光が照射された光導電性ボールの明部表面にイエロー、マゼンタ、シアン、ブラックのうちいずれか１つの帯電した着色材料を付着させて着色層を形成する着色工程と、該着色層を該光導電性ボール表面に定着させる定着工程と、を順次に繰り返して該複数の光導電性ボール全てに着色層を形成することを特徴とする表示装置の製造方法。

【請求項６】　請求項５に記載の表示装置は、前記複数の光導電性ボールを備えた絵素を複数有するように区分された画素を複数有しており、

前記複数の光導電性ボールの中の幾つかの光導電性ボールをマスクで選択する工程は、該１画素の中でいずれか１つの絵素をマスクで選択する工程である表示装置の製造方法。

【請求項７】　前記光導電性ボールが酸化亜鉛を有する請求項５又は請求項６に記載の表示装置の製造方法。

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【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、着色ボールの製造方法及び該着色ボールを回転させることにより表示を行う表示装置の製造方法に関する。

【０００２】

【従来の技術】近年、情報機器の発達に伴い、低消費電力且つ薄型の表示装置のニーズが増しており、これらニーズに合わせた表示装置の研究、開発が盛んに行われている。中でも液晶表示装置は、液晶分子の配列を電気的に制御し液晶の光学的特性を変化させる事ができ、上記のニーズに対応できる表示装置として活発な開発が行われ商品化されている。しかしながら、現在の液晶表示装置には、画面を見る角度や、反射光により、画面上の文字が見づらく、また光源のちらつき・低輝度等から生じる視覚への負担が、未だ十分に解決されていない。この為、視覚への負担の少ない新たな表示装置の研究が盛んに検討されている。

【０００３】新たな表示装置として、Ｎ．Ｋ．Ｓｈｅｒｉｄｏｎらにより電界駆動による微小ボールの回転を利用した表示装置が提案されている（“Ａ ｔｗｉｓｔｉｎｇＢａｌｌ Ｄｉｓｐｌａｙ”，Ｐｒｏｃ．ｏｆ ｔｈｅ ＳＩＤ，第１８巻３／４号、２８９－２９３頁，１９７７年、米国特許４１２６８５４号、同４１４３１０３号、同５３８９９４５号、特開昭６４－４２６８３号）。この表示装置は、微小なボールを用い、該ボールは一方の半球面が白色で、他方の半球面が黒色となっており、前記ボールを支持体に形成したキャビティ内に配し、各キャビティ内に高抵抗な液体を充填して、この液体中でボールが自由に回転できるようにしたものである。この場合、液体の種類により、ボールの黒色と白色の夫々の半球部分の相互の帯電状態が異なり、外部電界を与える事によってボールの白色又は黒色の半球面を観察する側にむけるよう回転を制御することができ、目的とする表示ができる。

【０００４】このような機械式の表示方法は、温度変化、電気的擾乱ノイズに対して極めて安定であり、メモリ性を有する為に表示中に電力を必要としない。さらに、ボール表面の自然光の反射・散乱を利用して表示する為に液晶装置・ブラウン管でみられるような光源のちらつき等にて起こる眼疲労を抑えることができる理想的な表示装置である。

【０００５】ところで、ボール回転による表示装置に用いる二色に着色された微小ボールの作製方法としては、前述したＳｈｅｒｉｄｏｎ等により、ガラスボールにＴｉＯ２を高濃度に含有させガラスボールを白色化し、この白色ガラスボール４１の半球面に真空蒸着法を用いて絶縁性の黒色層４２を形成する方法が提案されている（図４）。

【０００６】また、斎藤等（“Ａ　Ｎｅｗｌｙ　Ｄｅｖｅｌｏｐｅｄ　Ｅｌｅｃｔｒｉｃａｌ　Ｔｗｉｓｔｉｎｇ　Ｂａｌｌ　Ｄｉｓｐｌａｙ”，　Ｐｒｏｃ．　ｏｆ　ｔｈｅ　ＳＩＤ，　第２３巻４号，２４９－２５３頁，１９８２年）も同様な方法により二色ボールを形成しており、白色化したガラスボールの半球面に真空蒸着法を用いてＭｇＦ２とＳｂ２Ｓ３を同時蒸着し黒色層を成膜して色分けしている。ガラスボールの白色化に際しては、ＬｉＯ２とＴｉＯ２とＳｉＯ２の３成分からなるガラスを用いて、熱処理を行い光散乱が起こるように成分分離し、異なる成分からなる表面状態を形成することにより作製する。

【０００７】

【発明が解決しようとする課題】図４に示したように白色ボール上に真空蒸着法により黒色層を成膜するボールの二色化の方法は、薄膜形成を用いることで作製再現性が高い方法である。しかしながら、真空蒸着法により成膜を行なうには、工程が多く、また生産性が低い。

【０００８】真空引き時および成膜後のリーク時の気流によりボールが舞い上がるのを防ぐために微小ボールを固定し、成膜後ボールを回収するために固定を解除する必要があるし、真空蒸着できる真空度に達するまでに時間を要するなどの理由で、１バッチで量産できる数量に限度がある。

【０００９】よって、着色微小ボールを低コストに作製することを困難としている。この為に、表示装置の材料コストが高く、表示装置自体を安価に製造できないという課題があった。このような表示装置を商品化する上で、着色ボールの低コスト化が望まれていた。

【００１０】

【課題を解決するための手段】かかる目的を達成する本発明の表示装置は、微小ボールが回転することにより表示を行う表示装置であって、光導電性を利用して帯電・露光・現像処理して微小ボールの半球表面を着色した着色ボールを形成することで、真空蒸着法より安価な着色微小ボールを入手・作製することが可能となる。

【００１１】あるいは、光導電性を利用して帯電・露光・現像処理して微小ボールの一方の半球表面を白に着色した後、他方の半球表面を白以外の色に着色した着色ボールを形成することで、コントラストが高く、且つ安価な着色微小ボールを入手・作製することが可能となる。

【００１２】さらには、白色の酸化亜鉛球を用いれば白く着色する必要がなく、且つ酸化亜鉛の光導電性を利用して帯電・露光・現像処理して微小ボールの半球表面のみを白以外の色に着色した着色ボールを形成することで、より安価な着色微小ボールを入手・作製することが可能となる。

【００１３】

【発明の実施の形態】本発明の表示装置の駆動原理の一例を図９を用いて説明する。本発明の表示装置は、着色

層を形成した着色ボールと、該着色ボールを回転自在に支持する支持体５と、着色ボールが自在に回転できる為のキャビティ７とで構成された表示媒体と、該着色ボールを回転し所望の着色層側を表示させる為の電極６、６’と電源８より構成される駆動手段よりなる。また、該キャビティは誘電性液体で満たされている。着色層２は、反射光の色、反射強度の差を用いることにより観察側からみて異なる色層を表示できればよい。微小ボール表面上に着色層を被覆することにより、反射光の色、反射強度等の光学的特性の異なる２つの表面を作り出している。

【００１４】また、微小ボールの形状としては、球体のような曲面形状のものであれば良い。

【００１５】液体中の粒子は、粒子と液体の間で電荷の授受が行われ電気二重層が形成され、粒子は正または負に帯電することが知られている。本発明の微小ボールでは半球表面に着色層２が形成され、他の半球面は未着色である為、２つの異なる物質からなる領域を有する。よって、絶縁性液体から着色ボール表面に正イオン粒子又は負イオン粒子が特異吸着して、着色ボール表面に表面電位が生じる。この為、絶縁性液体中では各領域で帯電電荷特性が異なることとなり、着色ボールの極方向に双極子モーメントを持つようになる。。この着色ボールに電場を印加すると着色ボールにはその極方向を電界方向に揃えようとするトルクが働き、着色ボールはいずれかの半球面を一方向に揃える。図９のように、未着色領域がマイナス帯電し、着色層がプラス帯電しているとすると電源８にてプラスが印加された電極６’に未着色側が、マイナスが印加された電極６に着色側がくる。これにより図面上部より本発明の表示装置を観察すると着色層（黒色）が見える。電界の方向を逆転すれば着色ボールは反転し、着色側を観察側に向け光導電性ボールが白色材料である場合は、白色が見える。

【００１６】図１０に示すように、着色ボール、絶縁性液体で満たされたキャビティ７内を有する支持体５で構成された表示媒体を整形し、表示媒体の上下面に複数の電極を配置し、対向配置された電極間に電圧を印加することにより、該電圧の極性に従う表示色を表示することができる。

【００１７】前記の絶縁性液体に用いる液体としては、電気的絶縁性の高い液体であればよくトルエン、アセトン等の有機溶剤や水を用いることが可能であるが、間隙を満たす誘電性液体が揮発しないよう、不揮発性の液体を用いることが好ましい。特にシリコーンオイルはイオンや不純物の含有量が低く、高抵抗な液体であり好ましい。また、絶縁性液体は、着色ボールと接触して、２つの異なる物質からなる領域を有する着色ボール表面を界面活性化させ、異なる２つの帯電電荷状態を誘発する性質を有する。

【００１８】キャビティ７のの寸法としては、着色ボー

ルの並進をなるべく防止し、メモリ性を有するため、着色ボールより少し大きいぐらいが好ましい。

【００１９】また、着色ボールを駆動するに用いる電極としては、観察側からみて、微小ボールの表面に形成した着色層を観察できるよう、光透過であることが必要である。この為、ＳｎＯ２、ＴｉＯ２、ＺｎＯ、ＩＴＯ等の透明導電膜を用いる。

【００２０】支持体（光透過シート）としては、微小ボールの着色層を表示する為に、光学的に透明であることが必要であり、ポリエチレン、ポリスチレン、等の硬質の樹脂やシリコーンゴム、ガラス等を用いる。

【００２１】本発明の表示装置は、キャラクタ、グラフィック、ビデオ等の画像情報を表示する受光型表示装置に適用できる。また、紙のように見れ、紙のように動かせ、画像を書き込め、画像を複写でき、画像を読み込め、画像を消去できるペーパーディスプレイにも適用できる。

【００２２】本発明は、別の実施形態をとっても良い。本発明の第２の表示装置では、着色ボールを透明な絶縁性液体と共に支持体（光透過シート）に形成されたキャビティ（空洞）中に分散させる以外の構成をとる。着色ボール間に単に絶縁性液体のみを介在させる構成をとるものである。

【００２３】本発明の第２の表示装置の１つの例を図１１を用いて説明する。着色ボール１００５は、光導電性ボールの半球表面に着色層が被覆されている（図示せず）。第１の透明電極１００１を有する第１の透明基板１００２と第１の透明基板と相対向し且つ第２の透明電極１００３を有する第２の透明基板１００４との間の空間を封止部（図示せず）により閉じた空間で構成し、この空間内の着色ボール１００５間を絶縁性液体１００６で充填する。閉じた空間を絶縁性液体で充填し、絶縁性液体中に着色ボールが分散された状態を示す。つまり、着色ボール１００５及び絶縁性液体１００６とで構成される表示媒体を透明電極を有する透明基板等で閉じる構成をとる。

【００２４】更に、本発明の表示装置は、反射光が可視光波長領域以外の波長領域でも良い。例えば、室内が、赤外光波長領域でも本発明の表示装置を適用できる。

【００２５】微小ボールの材料としては、光導電性のあるものならば無機材料、有機材料のどちらでも良いが、白い酸化亜鉛が特に好ましい。酸化亜鉛以外には硫化カドミウム、セレン、シリコン、銅フタロシアニンなどの光導電性物質を主たる原料とし、これに分光増感材、バインダー樹脂、電荷輸送物質などを添加してもよい。

【００２６】微小ボールの寸法としては、ボールの直径が表示装置としての一画素以下の大きさとなるよう、２００μｍ以下のものが好ましい。

【００２７】本発明の微小ボール形成方法の一例として、酸化亜鉛ボールの形成方法としては酸化亜鉛の塊を粉砕・分級する、酸化亜鉛溶液をノズルから吐出して溶媒を瞬時に気化させるなどの方法により微小ボール形状とすることができる。

【００２８】あるいは酸化亜鉛の微粒子を微小ポリマーボールに分散させてもよい。

【００２９】着色ボールの形成方法としては、上記した微小ボールが光導電性を有することを利用し、微小ボールを帯電させ、微小ボールに片側から露光し、現像・定着することにより微小ボールの半球表面に着色層を形成する。帯電・露光・現像・定着の各工程は電子写真に準ずる。帯電はコロナ放電を用いることができる。露光は光導電性の特性に応じた波長の光を用いることができる。現像は着色トナー微粒子や磁性トナーをもちいて行ない熱定着する、あるいは、帯電したインクで現像したり、メッキ法により着色することもできる。

【００３０】現像は暗部が着色されるポジ型と、逆に明部が着色されるネガ型（いわゆる反転現像）のいずれも可能であるが、図３ではネガ型の例を示した。

【００３１】光導電性を有する微小ボールの半球のみが着色される原理を簡単に説明する。

【００３２】導電性基板の上に設置した、図６のような形状の、厚さの異なる絶縁膜を帯電させると、厚さに対応して表面電位が高くなる。同様に、微小ボールを導電性基板の上で帯電させると、その表面電位は一様ではなく、導電性基板に近い部分は表面電位が低く、導電性基板から最も遠い球の頂点部は表面電位が高くなる。

【００３３】この暗状態で逆極性のトナーでポジ現像すると、表面電位に応じてトナー濃度が変化し、頂点部は濃く、導電性基板に近い部分は薄く、連続的な濃度分布をもって着色される（図７）。

【００３４】また、前記帯電状態にボール頂点部より均一露光すると、ボールが不透明であるためにボールの上部のみが導電性になり、影となるボール下部は高抵抗のままである（図８）。ボール頂点部の表面電荷は導電性基板に向ってボール内部を通過して流れ（図８破線矢印）、トラップされていた正孔と再結合したりして表面電荷が消失する。これを表面電位と同極性のトナーを用い、現像器と導電性基板との間にバイアス電圧を印加しながら反転現像をおこなうと、半球上部のみが着色される。

【００３５】また、従来、酸化亜鉛を用いた電子写真法を応用したものとして、エレクトロファックスが知られているが、本発明では酸化亜鉛を球状とし、その半球のみを着色しこれを回転させることで可逆的な表示を可能としているので、本質的に異なる表示システムである。

【００３６】

【実施例】以下実施例を用いて詳細に説明する。

【００３７】（実施例１）図１は本発明の表示装置に用いる微小ボールの断面図である。図２は自然光４を照射した時の観察側から見える微小ボールの色を説明する図

である。微小ボールは、可視光波長領域にて不透明な光導電性ボールからなり、半球面に着色層が形成されている。図２より、観察側から見て、微小ボールの着色側が観察側に向いた場合には着色層の色を見ることとなり（図２（ａ））、微小ボールの未着色側が観察側に向いた場合には光導電性ボールの地の色が見えることとなる（図２（ｂ））。

【００３８】図３は本発明の微小ボールの形成方法の工程を示す断面図である。本実施例では、光導電性ボール１として、平均直径５０μｍの酸化亜鉛球を用いた。アルミシートからなる導電性基板１１上に微小ボールを散布し、この表面に２ＫＶのコロナ帯電を施し、表面より一様露光し、つづいてキャノン製ＬＢＰ－Ａ４０８の平均直径５μｍの黒色トナーで反転現像を行ない、１８０℃に加熱してトナーを溶融し定着し（不図示）、黒色の着色層２を形成した（図３）。

【００３９】なお、露光には酸化亜鉛の分光特性を考慮して、３５０ｎｍの紫外線を用いた。

【００４０】（実施例２）この着色した微小ボールを、前述したＳｈｅｒｉｄｏｎ等と同様な方法で、エラストマー中に混合し、これをシート状に成形硬化し、このエラストマーシートをシリコーンオイルに浸漬して膨潤させることにより各微小ボールの周囲にキャビティを形成し、シート状の表示装置を作製した。具体的には、２液型シリコーンゴム（ダウコーニング社製シルポット１８４）中に前記微小ボールを分散させた。次にガラス基板上でこの分散系を厚さ約１００μｍの膜状に伸ばし、該シリコーンゴムを１００℃、１時間の条件で加熱硬化させた。次に上記微小ボール分散硬化ゴムシートをガラス基板より剥離し、粘度１ｃｓのシリコーンオイル（東芝シリコーン社製）中に２４時間浸漬して該ゴムシートを膨潤させ、微小ボールの周囲にキャビティ（隙間５－１０μｍ）を形成させた。次に、前記ゴムシートをＩＴＯ電極膜付きガラス基板で挟持させて、表示装置を作製した。該表示装置に±１００Ｖの電界を印加すると、微小ボールがキャビティ内で回転することにより、電界の極性に応じて観察側に着色層を形成した半球面、または未形成の半球面が現れた。応答速度は５０ｍｓ以下であった。詳しくは、観察側に印加した電界の（＋）側が来ると、微小ボールが回転し、未着色な半球面があらわれ、観察側からにて表示装置が白色となった。電界の極性を変えると、着色層のある半球面があらわれ黒色を表示した。すなわち、本発明の表示装置では、白色の酸化亜鉛ボールの半球面にのみ着色層を形成し、従来技術と同等の表示を安価に提供することができた。この際、コントラスト比は約５：１であった。また視野角特性は±８５°以上であった。すなわち、本発明の表示装置では、透明なガラスボールの半球面にのみ２層の着色層を形成し、従来技術の白色ボールに黒色層を形成した着色ボールと同等の表示を提供することができた。

【００４１】以上示したように、本発明の表示装置により、白色化する工程の無い微小ボールを用いて、２色表示を達成することが可能となった。この表示装置に用いる微小ボールは、安価に入手することが可能な白色の酸化亜鉛の微小ボールを使用でき、さらに着色する工程も微小ボールの半球面のみに所望の色の着色層を形成する工程となり、２色表示可能な微小ボールを作製することが容易である。このことにより表示装置の価格を低くおさえることが可能となった。

【００４２】（実施例３）１０ｗｔ％ポリカーボ樹脂ＴＨＦ溶液に平均直径５μｍの酸化亜鉛を１０ｗｔ％の濃度で分散させ、平均直径５０μｍのガラスボール表面に一様に塗布し、ガラスボール表面の樹脂薄膜内に酸化亜鉛を固定担持させた。これにより、光導電性および白色化を同時におこなうことができた。これを実施例１と同様の手段で着色した。

【００４３】（実施例４）平均直径５０μｍの酸化亜鉛球から成る未着色の微小ボールを、実施例２と同様な方法で、エラストマー中に混合し、これをシート状に成形硬化した。これに帯電・露光し、このエラストマーシートをニグロシンを主成分とする黒色インクを溶解したシリコーンオイルに浸漬して酸化亜鉛球を液体現像しながらエラストマーシートを膨潤させた。そして、２００℃に１分間加熱保持して定着を行い、黒色の着色層を形成した。つづいてインク未添加のシリコーンオイルで余剰のインクを洗浄し、半球表面を着色した微小ボールを得、且つ微小ボール周囲にキャビティを形成し、シート状の表示装置を作製した。

【００４４】（実施例５）実施例４においてエラストマーシート（図５（ａ））を帯電し、図５（ｂ）に例示したようにイエローの場合にはブルーの絵素マスクをしながら露光し、イエロー、マゼンタ（グリーン絵素マスク）、シアン（レッド絵素マスク）、黒（ＮＤ絵素マスク＝可視領域においてフラットな吸収を有するマスク）のうち一つの色のインクを溶解したシリコーンオイルで現像した。

【００４５】絵素マスクを交換あるいは移動しながら、この処理を各色についておこない、イエロー、マゼンタ、シアン、黒の４つの絵素を形成し、この４つの絵素で１つの画素を構成した（図５（ｃ））。画像は複数の画素で構成される。各画素の各絵素を白、イエロー、マゼンタ、シアン、黒のいずれかに選択することでカラーの画像を表示する。

【００４６】つまり、本実施例では、複数の光導電性ボールを光透過シートに分散させる工程と、該複数の光導電性ボールを帯電させる帯電工程と、該複数の光導電性ボールの中の幾つかの光導電性ボールをマスクで選択する工程と、選択された光導電性ボールの一部表面に光を照射する露光工程と、着色材料を有する絶縁性液体に浸して光が照射された光導電性ボールの明部表面にイエロ

一、マゼンタ、シアン、ブラックのうちいずれか１つの帯電した着色材料を付着させて着色層を形成する現像工程と、該着色層を該光導電性ボール表面に定着させる定着工程と、を順次に繰り返して該複数の光導電性ボール全てに着色層を形成する。

【００４７】本実施例の製造方法をとることにより、複数の微小白色ボールの半球表面をイエロー、マゼンタ、シアン、黒のいずれかに着色して着色ボールを複数作製した後に、エラストマーシートに４つの絵素で１画素を構成するように着色ボールを分散させて表示装置を作製する場合に比べて、製造プロセスが簡易となる。

【００４８】（実施例６）図１２は本発明の第１の実施形態を利用した表示装置の一例の概略構成を示すものである。図１２（ａ）は平面図、図１２（ｂ）は断面図である。先ず、透明な下部ＩＴＯ電極２１０２で全面を被覆された厚さ１００μｍのＰＥＴフィルム２１０１上に、実施例１で述べた着色ボール２１０３を分散させて成るゴムシート２１０４を厚さ１００μｍに形成した。係るシート上に、所望の形状にパターニングされた透明な上部ＩＴＯ電極２１０６を有する厚さ１００μｍのＰＥＴフィルム２１０５を、上部ＩＴＯ電極２１０６が前記ゴムシート２１０４と対向する向きに圧着した。上部ＩＴＯ電極２１０６の形状・サイズは、所望の解像度に合わせて選択する必要があるが、本実施例では簡単にするため、従来公知の７セグメント・タイプを用いた。各上部電極２１０６とパルス発生器２１０７を接続し、波高値１００Ｖ、パルス幅５０ｍｓの矩形波を全電極に印加して、全面を白色状態とした。次に、上部ＩＴＯ電極２１０６の内、任意のものをスイッチ２１０８で選択した上で、先程とは逆極性のパルスを印加したところ、選択した上部ＩＴＯ電極に相当する個所のみ着色ボール２１０３が回転し黒色化し、セグメント形状の組み合わせを利用した表示（数字やアルファベットの一部）が可能であることを確認した。また、係る黒色表示セグメントに先程のパルスとは逆極性のパルス（最初のパルスと同極性）を印加したところ、黒色表示が再度白色表示に戻ることを確認した。

【００４９】（実施例７）実施例６で用いた７セグメント・タイプの構成に変えて、下部電極２１１２、上部電極２１１３をストライプ状のＩＴＯ電極で構成した。ストライプ状のＩＴＯ電極幅及びその電極間の間隔は、４０μｍとした。下部電極２１１２と上部電極２１１３とは互いに直交するように配置した表示装置を作成した。係る表示装置の概略構成を図１３（ａ），１３（ｂ）に示す。全下部電極２１１２と全上部電極２１１３に不図示のパルス発生器を用いて波高値１００Ｖ，パルス幅５０ｍｓの矩形波を加えて、全面を白色状態とした。次に任意の下部電極２１１２と上部電極２１１３とを選び、係る電極間に上記パルス発生器を用いて逆極性のパルスを印加したところ、両電極が交差する領域において、着色ボール２１０３が回転して、黒色化した。すなわちパルス印加する電極の組み合わせを選択することにより、所望の領域を黒色表示できることを確かめた。また、さらに黒色表示をもたらすパルスとは逆極性のパルスを印加することにより、黒色表示部分が再度白色表示に戻ることを確認した。

【００５０】

【発明の効果】以上説明したように、着色ボールが回転することにより表示を行う表示装置において、前記微小ボールの一方の半球表面に光導電性を利用して着色層を形成することで、安価な微小ボールを用いることができ、表示装置の価格を低く抑えることが可能となった。

【００５１】すなわち、真空蒸着のような気流の影響も少ないので、着色ボールを固定する必要もない。また、真空蒸着材料より安価なトナーを用いることで材料費を低く抑えた。さらに着色は大気中にて行なわれるので、真空蒸着よりタクトタイムが短く生産性が向上し、量産効果により価格を安くすることができた。

【００５２】また、酸化亜鉛球は白色であり、この球を用いてコントラストの高い表示装置を得た。

【００５３】さらには、表示面を複数の絵素に分解し、それぞれの絵素をイエロー、マゼンタ、シアンおよび黒のいずれかに同様の方法で着色することにより、簡単且つ安価にカラー化できた。また、酸化亜鉛球は白色であるので、高いコントラストを示す。

【図面の簡単な説明】

【図１】本発明の第１の表示装置に用いる着色ボールの断面図である。

【図２】本発明の第１実施例の観察側から見える着色ボールの表示色を説明する図である。

【図３】本発明の第１実施例の着色ボールの形成工程を示す図である。

【図４】従来例の着色ボールを説明する断面図である。

【図５】カラー化する場合のシート、マスクおよび４色重ね合わせた結果の一例である。

【図６】帯電電位を説明する図である。

【図７】暗時ポジ現像した場合の例である。

【図８】ボール頂点より露光し、反転現像した場合の例を示す図である。

【図９】本発明の表示装置の原理を示す図である。

【図１０】本発明の表示装置を示す図である。

【図１１】本発明の第２の表示装置を示す図である。

【図１２】本発明の実施例６に用いられる表示装置を示す図である。

【図１３】本発明の実施例７に用いられる表示装置を示す図である。

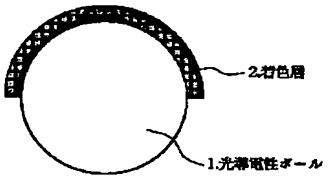
【符号の説明】

１　光導電性ボール
２　着色層
４　自然光

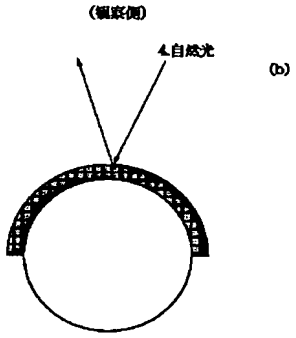
11　　12

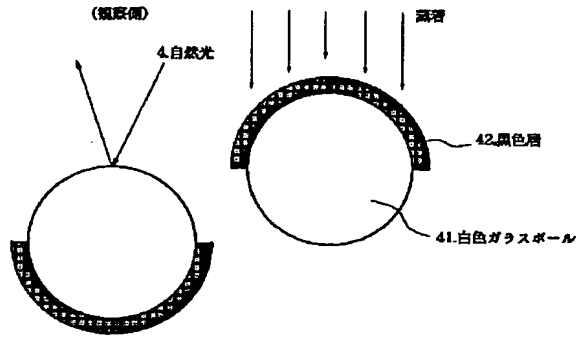
３１　基板
３２　帯電器
３３　露光
３４　現像器
４１　白色ガラスボール
４２　黒色層
５１　一様に光導電性球を分散させたシート
５２　Ｙ（黄色）用露光マスク
５３　Ｙ、Ｍ、Ｃ、Ｂｋ用の各露光マスクにより露光・現像した絵素および画素

【図１】



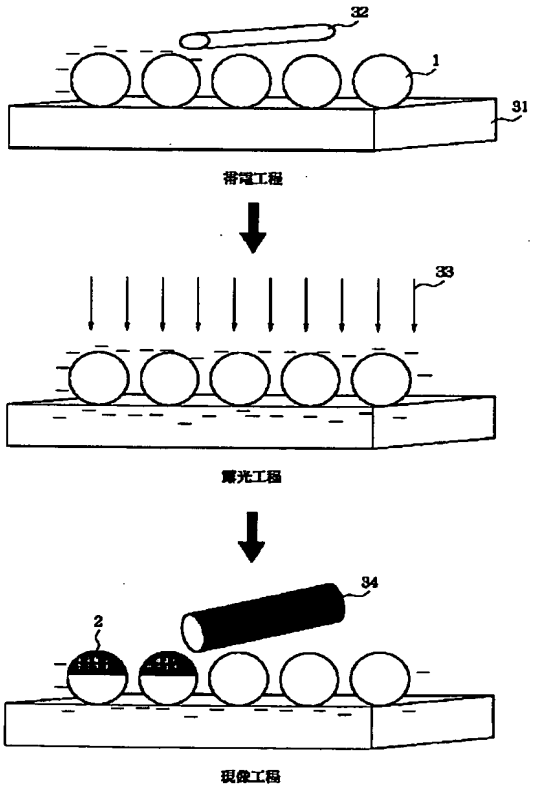
【図２】





【図４】

【図３】



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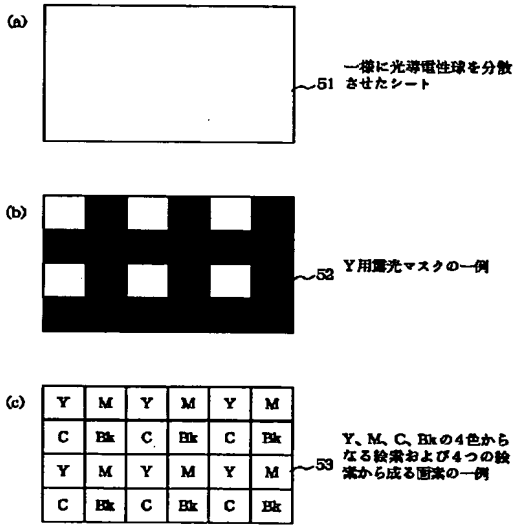

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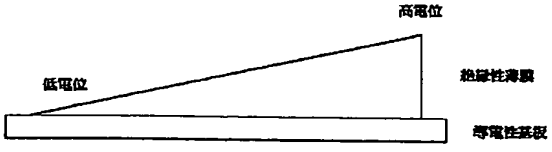
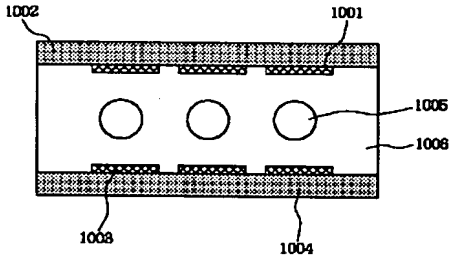


【図７】

【図１１】



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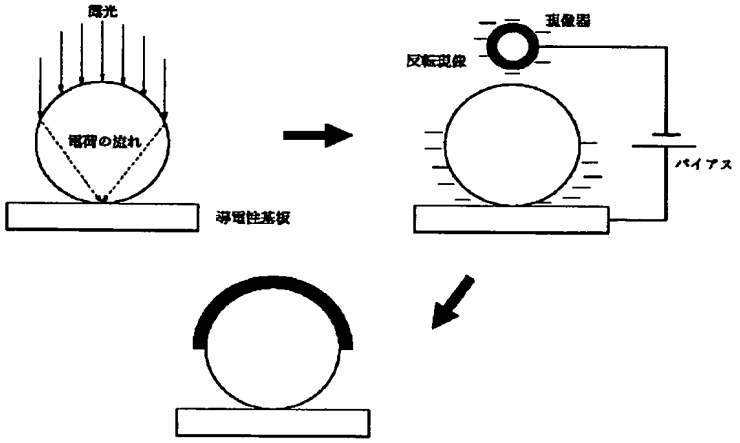

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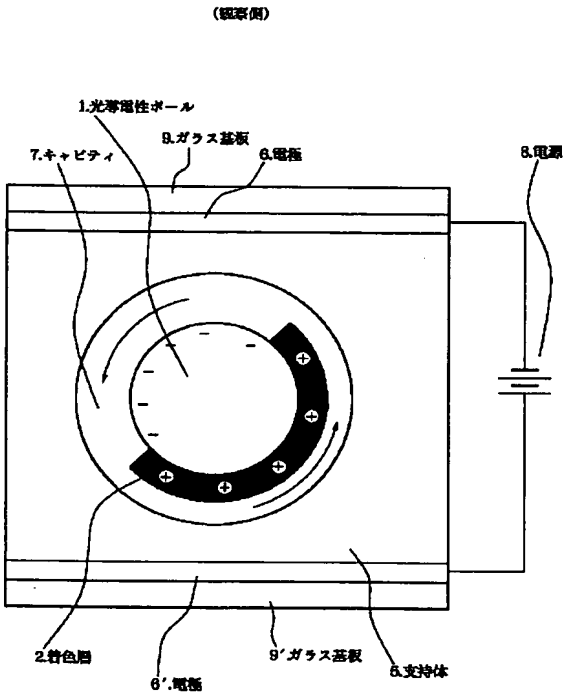

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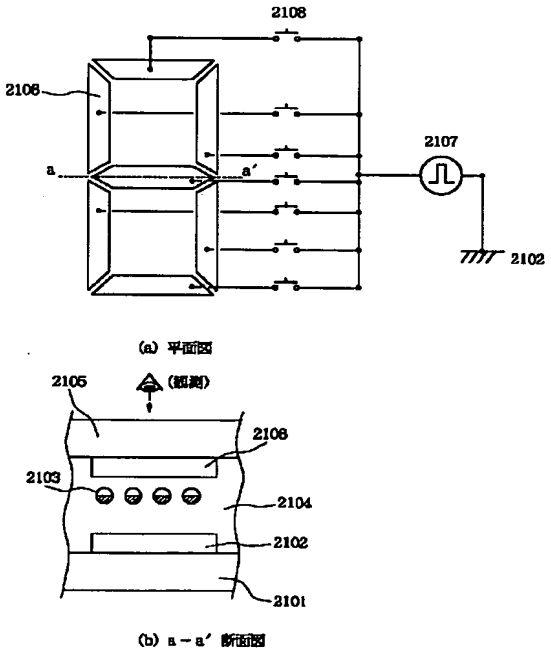

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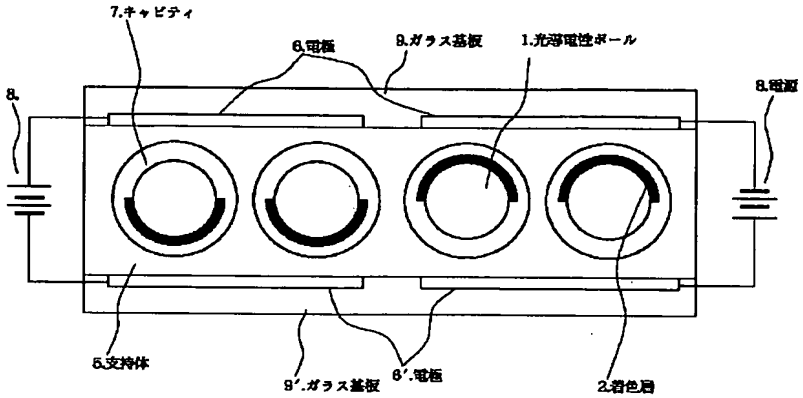

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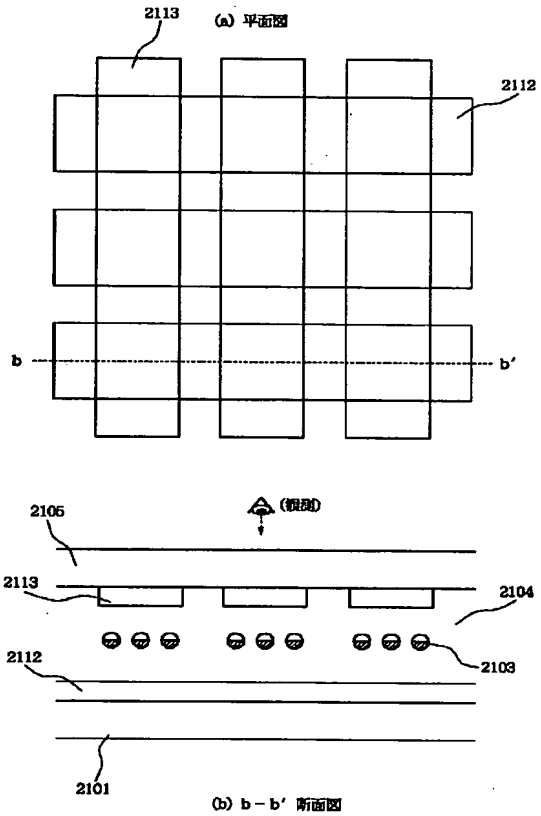

フロントページの続き

(72)発明者　貴志　悦朗
東京都大田区下丸子３丁目30番２号キヤノン株式会社内

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

CLAIMS

[Claim(s)]
[Claim 1] The electrification process which electrifies a photoconductivity ball, and the photoconductivity ball of an electrification condition a part The exposure process which irradiates light on a front face, The manufacture approach of the coloring ball characterized by having the coloring process which the charge of a coloring matter charged on the umbra front face of the photoconductivity ball with which the bright section front face or light of the photoconductivity ball with which light was irradiated is not irradiated is made to adhere, and forms a coloring layer, and the fixing process which fixes this coloring layer to this photoconductivity ball front face.
[Claim 2] The manufacture approach of a coloring ball according to claim 1 that said photoconductivity ball has a zinc oxide.
[Claim 3] In the manufacture approach of the display which displays by rotating the coloring ball equipped with two front faces where optical properties differ The process which makes a light transmission sheet distribute a photoconductivity ball, and the electrification process which electrifies this photoconductivity ball, The photoconductivity ball of an electrification condition a part The coloring process which the charge of a coloring matter charged on the umbra front face of the photoconductivity ball with which the exposure process which irradiates light on a front face, and the bright section front face or light of the photoconductivity ball with which it dipped in the dielectric liquid which has a charge of a coloring matter, and light was irradiated is not irradiated is made to adhere, and forms a coloring layer, The manufacture approach of the display characterized by having the fixing process which fixes this coloring layer to this photoconductivity ball front face, the process which distributes the ball with which this coloring layer was formed in a display medium, and the process which forms an electrode on this display medium front face.
[Claim 4] The manufacture approach of a display according to claim 3 that said photoconductivity ball has a zinc oxide.
[Claim 5] In the manufacture approach of the display which displays by rotating the coloring ball equipped with two front faces where optical properties differ The process which makes a light transmission sheet distribute two or more photoconductivity balls, and the electrification process which electrifies these two or more photoconductivity balls, The process which chooses some photoconductivity balls in these two or more photoconductivity balls with a mask, On the bright section front face of the photoconductivity ball with which it dipped in the exposure process of the selected photoconductivity ball which irradiates light on a front face, and the insulating liquid which has a charge of a coloring matter, and light was irradiated, in part Yellow, A Magenta, cyanogen, and the coloring process that any one electrified charge of a coloring matter is made to adhere among Black, and forms a coloring layer, The manufacture approach of the display characterized by repeating successively the fixing process which fixes this coloring layer to this photoconductivity ball front face, and forming a coloring layer in these two or more photoconductivity balls of all.
[Claim 6] the process which the indicating equipment according to claim 5 has two or more pixels classified so that it might have two or more picture elements equipped with said two or more

photoconductivity balls, and chooses some photoconductivity balls in said two or more photoconductivity balls with a mask -- this -- the manufacture approach of the indicating equipment which is the process which chooses any one picture element with a mask in 1 pixel.
[Claim 7] The manufacture approach of a display according to claim 5 or 6 that said photoconductivity ball has a zinc oxide.

[Translation done.]

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the manufacture approach of the display which displays by rotating the manufacture approach of a coloring ball, and this coloring ball.
[0002]
[Description of the Prior Art] In recent years, with development of information machines and equipment, the needs of a low power and a thin display are increasing, and research of the display set by these needs and development are performed briskly. Especially, a liquid crystal display can control the array of a liquid crystal molecule electrically, can change the optical property of liquid crystal, and development active as a display which can respond to the above-mentioned needs is performed, and it is commercialized. However, the burden to the include angle which looks at a screen, and the vision which the alphabetic character on a screen is hard to look at, and is produced from a flicker, low brightness, etc. of the light source by the reflected light is not yet solved fully by the current liquid crystal display. For this reason, research of a new display with few burdens to vision is considered briskly.
[0003] as a new indicating equipment -- N.K -- the indicating equipment which used rotation of the minute ball by electric-field drive by Sheridon and others is proposed ("A twistingBall Display", Proc. of the SID, volume [18th] No. 3/4, 289 - 293 pages, 1977, and a U.S. Pat. No. 4126854 number -- said -- No. 4143103 -- said -- No. 5389945 and JP,64-42683,A). the inside of the cavity which one semi-sphere side of this ball is white, has become black [the semi-sphere side of another side], and formed said ball in the base material using the ball with this minute indicating equipment -- allotting -- the inside of each cavity -- high -- it is filled up with a liquid [****] and a ball enables it to rotate freely in this liquid In this case, the mutual electrification conditions of each semi-sphere part of the black and white of a ball differ, rotation can be controlled by the class of liquid to turn to the side which observes the white or the black semi-sphere side of a ball by giving external electric field, and the target display can be performed.
[0004] Since it is very stable and has memory nature to a temperature change and an electric turbulence noise, while displaying such the mechanical method of presentation, it does not need power. Furthermore, in order to display using reflection and dispersion of the natural light on the front face of a ball, it is the ideal display which can stop the eye strain which happens by flicker of the light source which is seen with liquid crystal equipment and the Braun tube etc.
[0005] By the way, the approach of making a glass bowl contain TiO2 in high concentration, whitening a glass bowl, using a vacuum deposition method for the semi-sphere side of this white glass bowl 41, and forming the insulating black layer 42 by Sheridon mentioned above, as the production approach of the minute ball colored the two color used for the indicating equipment by ball rotation, is proposed (drawing 4).
[0006] Moreover, the two-color ball is formed by the same ("A Newly Developed Electrical Twisting Ball Display", Proc. of the SID, volume [23rd] No. 4, 249 -253 pages, 1982) approach, a vacuum deposition method is used for the semi-sphere side of the glass bowl which whitened, the coincidence vacuum evaporationo of MgF2 and Sb2S3 is carried out, and Saito etc. is

forming and classifying the black layer by color. Segregation is carried out and it produces by forming the surface state which consists of a different component so that it may heat-treat on the occasion of whitening of a glass bowl using the glass which consists of LiO2 and three components of TiO2 and SiO2 and light scattering may happen.
[0007]
[Problem(s) to be Solved by the Invention] The approach of two-color-izing of the ball which forms a black layer with vacuum evaporation technique on a white ball as shown in drawing 4 is an approach that production repeatability is high, in using thin film formation. However, in order to form membranes with a vacuum deposition method, there are many processes and productivity is low.
[0008] In order to fix a minute ball in order to prevent a ball soaring according to the air current at the time of vacuum suction and the leak after membrane formation, and to collect the balls after membrane formation, it is necessary to cancel immobilization, and a limit is in the quantity which can be mass-produced in one batch by the reasons of taking time amount to reach the degree of vacuum which can carry out vacuum deposition.
[0009] Therefore, it makes it difficult to produce a coloring minute ball to low cost. For this reason, the technical problem that the ingredient cost of a display was high and could not manufacture the display itself cheaply occurred. When commercializing such an indicating equipment, low cost-ization of a coloring ball was desired.
[0010]
[Means for Solving the Problem] The indicating equipment of this invention which attains this purpose is an indicating equipment which displays when a minute ball rotates, is forming electrification and exposure, and the coloring ball that carried out the development and colored the semi-sphere front face of a minute ball using a photoconductivity, and becomes possible [coming to hand and producing a coloring minute ball cheaper than vacuum evaporation technique].
[0011] Or using a photoconductivity, electrification and exposure, and after carrying out a development and coloring white one semi-sphere front face of a minute ball, contrast becomes possible [coming to hand and producing a cheap coloring minute ball highly] by forming the coloring ball which colored the semi-sphere front face of another side colors other than white.
[0012] Furthermore, it becomes possible to come to hand and produce a cheaper coloring minute ball by it not being necessary to color white and, if a white zinc-oxide ball is used, and forming electrification and exposure, and the coloring ball that carried out the development and colored only the semi-sphere front face of a minute ball colors other than white using the photoconductivity of a zinc oxide.
[0013]
[Embodiment of the Invention] An example of the drive principle of the display of this invention is explained using drawing 9 . The indicating equipment of this invention consists of an electrode 6 for rotating this coloring ball and making a desired coloring layer side display it as the display medium which consisted of a coloring ball in which the coloring layer was formed, a base material 5 supported for this coloring ball, enabling free rotation, and a cavity 7 for a coloring ball to rotate free, and a driving means which consists of 6' and a power source 8. Moreover, this cavity is filled with the dielectric liquid. The coloring layer 2 just displays a pigmented layer which is different, in view of an observation side by using the color of the reflected light, and the difference of reflectivity. By covering a coloring layer on a minute ball front face, two front faces where optical properties, such as a color of the reflected light and reflectivity, differ are made.
[0014] Moreover, as a configuration of a minute ball, what is necessary is just the thing of a curved-surface configuration like a solid sphere.
[0015] Transfer of a charge is performed between a particle and a liquid, as for the particle in a liquid, an electric double layer is formed, and it is known that a particle will be charged in forward or negative. With the minute ball of this invention, the coloring layer 2 is formed in a semi-sphere front face, and since it has not colored, other semi-sphere sides have the field which consists of two different matter. Therefore, a cation particle or an anion particle carries out specific adsorption to a coloring ball front face from an insulating liquid, and surface potential arises on a

coloring ball front face. For this reason, in an insulating liquid, electrification charge properties will differ in each field, and it comes to have the dipole moment in the direction of a pole of a coloring ball. . If electric field are impressed to this coloring ball, on a coloring ball, the torque which is going to arrange that direction of a pole in the direction of electric field will work, and a coloring ball will arrange one of semi-sphere sides with an one direction. Supposing a non-colored field carries out minus electrification and the coloring layer is carrying out plus electrification like drawing 9 , a coloring side will come to the electrode 6 with which minus was impressed to electrode 6' to which plus was impressed with the power source 8 for the un-coloring side. When this observes the display of this invention from the drawing upper part, a coloring layer (black) can be seen. If the direction of electric field is reversed, it is reversed, and when a photoconductivity ball is a white ingredient, white can be seen [a coloring ball] towards a coloring side observation-side.

[0016] The foreground color according to the polarity of this electrical potential difference can be displayed by operating orthopedically the display medium which consisted of base materials 5 which have the inside of the cavity 7 filled with the coloring ball and the insulating liquid, arranging two or more electrodes to the vertical side of a display medium, and impressing an electrical potential difference to inter-electrode [by which opposite arrangement was carried out], as shown in drawing 10 .

[0017] Although it is possible to use organic solvents and water, such as toluene and an acetone, that what is necessary is just the high liquid of electric insulation as a liquid used for the aforementioned insulating liquid, it is desirable to use the liquid of a non-volatile so that the dielectric liquid which fills a gap may not volatilize. especially -- silicone oil -- the content of ion or an impurity -- low -- high -- it is a liquid [****] and is desirable. Moreover, an insulating liquid contacts a coloring ball, makes the coloring ball front face which has the field which consists of two different matter surface-activity-ize, and has the property which induces two different electrification charge conditions.

[0018] Since advancing side by side of a coloring ball is prevented if possible and it has memory nature as a dimension of cavity 7 **, about [than a coloring ball / somewhat larger] is desirable.

[0019] Moreover, as an electrode used for driving a coloring ball, in view of an observation side, it is required to be light transmission so that the coloring layer formed in the front face of a minute ball can be observed. For this reason, transparence electric conduction film, such as SnO2, TiO2, ZnO, and ITO, is used.

[0020] As a base material (light transmission sheet), in order to display the coloring layer of a minute ball, an optically transparent thing is required and hard resin and silicone rubber, such as polyethylene and polystyrene, glass, etc. are used.

[0021] The indicating equipment of this invention is applicable to the light-receiving mold indicating equipment which displays image information, such as a character, a graphic, and video. Moreover, it can see like paper, and can move like paper, an image can be written in, an image can be copied, an image can be read, and it can apply also to the paper display which can eliminate an image.

[0022] This invention is very good in another operation gestalt. In the 2nd indicating equipment of this invention, the configuration except distributing a coloring ball in the cavity (cavity) formed in the base material (light transmission sheet) with the transparent insulating liquid is taken. The configuration between which only an insulating liquid is made to be placed between coloring balls is taken.

[0023] One example of the 2nd display of this invention is explained using drawing 11 R> 1. As for the coloring ball 1005, the coloring layer is covered by the semi-sphere front face of a photoconductivity ball (not shown). It constitutes from space which closed the space between the 2nd transparence substrate 1004 which carries out phase opposite with the 1st transparence substrate 1002 which has the 1st transparent electrode 1001, and the 1st transparence substrate, and has the 2nd transparent electrode 1003 by the closure section (not shown), and between the coloring balls 1005 in this space is filled up with the insulating liquid 1006. The closed space is filled up with an insulating liquid and the condition that the coloring ball was

distributed in the insulating liquid is shown. That is, the configuration which closes the display medium which consists of a coloring ball 1005 and an insulating liquid 1006 with the transparence substrate which has a transparent electrode is taken.
[0024] Furthermore, wavelength fields other than a light wavelength field of the display of this invention are sufficient as the reflected light. For example, the interior of a room can apply the display of this invention also in an infrared light wavelength field.
[0025] Although either an inorganic material or an organic material is OK as an ingredient of a minute ball as long as there is a photoconductivity, especially a white zinc oxide is desirable. In addition to a zinc oxide, photoconductivity matter, such as a cadmium sulfide, a selenium, silicon, and a copper phthalocyanine, may be used as a main raw material, and spectral sensitization material, binder resin, the charge transportation matter, etc. may be added to this.
[0026] As a dimension of a minute ball, a thing 200 micrometers or less is desirable so that the diameter of a ball may serve as magnitude of 1 pixel or less as a display.
[0027] As an example of the minute ball formation approach of this invention, the zinc oxide solution which grinds and classifies the lump of a zinc oxide as the formation approach of a zinc oxide ball can be breathed out from a nozzle, and it can consider as minute ball shape by the approach of making a solvent evaporate in an instant etc.
[0028] Or a minute polymer ball may be made to distribute the particle of a zinc oxide.
[0029] As the formation approach of a coloring ball, it uses that the above-mentioned minute ball has a photoconductivity, and a minute ball is electrified, it exposes from one side on a minute ball, and a coloring layer is formed in the semi-sphere front face of a minute ball by being developed negatives and established. Each process of electrification, exposure, development, and fixing applies to electrophotography. Electrification can use corona discharge. Exposure can use the light of the wavelength according to the property of a photoconductivity. It is with a coloring toner particle or a magnetic toner, and heat fixing is carried out and carried out, or development can be developed in electrified ink or can also be colored with plating.
[0030] Although development was possible also for any of the positive type with which an umbra is colored, and the negative mold (the so-called reversal development) with which a bright section is colored conversely, drawing 3 showed the example of a negative mold.
[0031] The principle which only the semi-sphere of the minute ball which has a photoconductivity is colored is explained briefly.
[0032] If the insulator layer from which the thickness of a configuration like drawing 6 installed on the conductive substrate differs is electrified, corresponding to thickness, surface potential will become high. Similarly, if a minute ball is electrified on a conductive substrate, the surface potential will not be uniform, the part near a conductive substrate will have low surface potential, and, as for the top-most-vertices section of the furthest ball from a conductive substrate, surface potential will become high.
[0033] If positive development is carried out with the toner of reversed polarity in the state of this dark, toner concentration will change according to surface potential, and it will be colored with [the top-most-vertices section is deep, and the part near a conductive substrate is thin, and] continuous concentration distribution (drawing 7).
[0034] Moreover, when homogeneity exposure is changed into said electrification condition from the ball top-most-vertices section, since the ball is opaque, the ball lower part from which only the upper part of a ball becomes conductivity and serves as a shadow is still high resistance (drawing 8). The surface charge of the ball top-most-vertices section passes through the interior of Ball toward a conductive substrate, and it flows (drawing 8 broken-line arrow head), and it recombines with the electron hole by which the trap was carried out, and surface charge disappears. If reversal development is performed impressing bias voltage for this between a development counter and a conductive substrate using the toner of surface potential and like-pole nature, only the semi-sphere upper part will be colored.
[0035] Moreover, although the electrofax is known as a thing adapting the xerography using a zinc oxide, since it makes a zinc oxide spherical in this invention and the reversible display is conventionally enabled by coloring only the semi-sphere and rotating this, it is an essentially different display system.

[0036]
[Example] It explains to a detail using an example below.
[0037] (Example 1) Drawing 1 is the sectional view of the minute ball used for the indicating equipment of this invention. Drawing 2 is drawing explaining the color of the minute ball which appears from the observation side when irradiating the natural light 4. A minute ball consists of a photoconductivity ball opaque in a light wavelength field, and the coloring layer is formed in the semi-sphere side. When it sees from an observation side and a minute ball coloring-side turns to an observation side from drawing 2 , the color of a coloring layer will be seen (drawing 2 (a)), and when an un-coloring-minute ball side turns to an observation side, the color of the ground of a photoconductivity ball can be seen (drawing 2 (b)).
[0038] Drawing 3 is the sectional view showing the process of the formation approach of the minute ball of this invention. In this example, the zinc-oxide ball with an average diameter of 50 micrometers was used as a photoconductivity ball 1. The minute ball was sprinkled on the conductive substrate 11 which consists of an aluminum sheet, 2kV corona electrical charging was given to this front face, from the front face, uniform exposure was carried out, the black toner with an average diameter [of LBP-A408 made from canon] of 5 micrometers performed reversal development continuously, and it heated at 180 degrees C, and the toner was fused, it was established (un-illustrating), and the black coloring layer 2 was formed (drawing 3).
[0039] In addition, 350nm ultraviolet rays were used for exposure in consideration of the spectral characteristic of a zinc oxide.
[0040] (Example 2) By the same approach as Sheridon which mentioned this colored minute ball above, it mixed in the elastomer and shaping hardening of this was carried out at the shape of a sheet, by being immersed in silicone oil and making it swell this elastomer sheet, the cavity was formed in the perimeter of each minute ball, and the sheet-like display was produced.
Specifically, said minute ball was distributed in 2 liquid type silicone rubber (Dow Corning sill pot 184). Next, this dispersed system was developed with a thickness of about 100 micrometers in the shape of film on the glass substrate, and heat hardening of this silicone rubber was carried out on 100 degrees C and the conditions of 1 hour. Next, exfoliated the above-mentioned minute ball dispersion hardening rubber sheet from the glass substrate, and it was immersed into the silicone oil (Toshiba Silicone make) of viscosity 1cs for 24 hours, this rubber sheet was made to swell, and the cavity (five to 10 micrometer clearance) was made to form in the perimeter of a minute ball. Next, said rubber sheet was made to pinch with a glass substrate with an ITO electrode layer, and the display was produced. When the electric field of **100V were impressed to this indicating equipment, and a minute ball rotated within a cavity, the semi-sphere side which formed the coloring layer in the observation side according to the polarity of electric field, or the non-formed semi-sphere side appeared. The speed of response was 50 or less ms. When the (+) side came in detail, the minute ball rotated, the semi-sphere side [**** / un-] appeared, and the display became white from the observation side. [of the electric field impressed to the observation side] When the polarity of electric field was changed, the semi-sphere side with a coloring layer appeared, and black was displayed. That is, in the indicating equipment of this invention, the coloring layer was able to be formed only in the semi-sphere side of a white zinc oxide ball, and the display equivalent to the conventional technique was able to be offered cheaply. Under the present circumstances, the contrast ratio was about 5:1. Moreover, the angle-of-visibility property was **85 degrees or more. That is, in the indicating equipment of this invention, the display equivalent to the coloring ball which formed the two-layer coloring layer only in the semi-sphere side of a transparent glass bowl, and formed the black layer in the white ball of the conventional technique was able to be offered.
[0041] As shown above, it became possible to attain 2 color specification with the indicating equipment of this invention using a minute ball without the process which whitens. The minute ball used for this indicating equipment is easy to be able to use the minute ball of the zinc oxide of the white which can be received cheaply, and for the process colored further to also turn into a process which forms the coloring layer of a desired color only in the semi-sphere side of a minute ball, and to produce the minute ball in which 2 color specification is possible. It became possible to press down the price of a display low by this.

[0042] (Example 3) The 10wt% poly carbo resin THF solution was made to distribute a zinc oxide with an average diameter of 5 micrometers by 10wt(s)% concentration, it applied to the glass-bowl front face with an average diameter of 50 micrometers uniformly, and fixed support of the zinc oxide was carried out into the resin thin film on the front face of a glass bowl. Thereby, a photoconductivity and whitening were able to be performed to coincidence. The same means as an example 1 colored this.
[0043] (Example 4) The minute ball which is not colored [which consists of a zinc oxide ball with an average diameter of 50 micrometers] was mixed in the elastomer by the same approach as an example 2, and shaping hardening of this was carried out at the shape of a sheet. The elastomer sheet was made to swell, charging and exposing, being immersed in the silicone oil which dissolved the black ink which uses Nigrosine as a principal component for this elastomer sheet, and carrying out liquid development of the zinc-oxide ball to this. And it was fixed to 200 degrees C by having carried out heating maintenance for 1 minute, and the black coloring layer was formed. Excessive ink was continuously washed by ink non-added silicone oil, and the minute ball which colored the semi-sphere front face was obtained, and the cavity was formed in the perimeter of a minute ball, and the sheet-like display was produced.
[0044] (Example 5) It exposed carrying out a blue picture element mask in the case of yellow, as it is charged and the elastomer sheet (drawing 5 (a)) was illustrated to drawing 5 (b) in the example 4, and negatives were developed by yellow, the Magenta (Green picture element mask), cyanogen (red picture element mask), and the silicone oil that dissolved the ink of one color among black (ND picture element mask = mask which has flat absorption in a visible region).
[0045] Exchanging or moving a picture element mask, this processing was performed about each color, yellow, a Magenta, cyanogen, and four black picture elements were formed, and one pixel consisted of these four picture elements (drawing 5 (c)). An image consists of two or more pixels. The image of a color is displayed by choosing each picture element of each pixel as white, yellow, a Magenta, cyanogen, or black.
[0046] That is, the process which makes a light transmission sheet distribute two or more photoconductivity balls in this example, The electrification process which electrifies these two or more photoconductivity balls, and the process which chooses some photoconductivity balls in these two or more photoconductivity balls with a mask, On the bright section front face of the photoconductivity ball with which it dipped in the exposure process of the selected photoconductivity ball which irradiates light on a front face, and the insulating liquid which has a charge of a coloring matter, and light was irradiated, in part Yellow, A Magenta, cyanogen, the development process that any one electrified charge of a coloring matter is made to adhere among Black, and forms a coloring layer, and the fixing process which fixes this coloring layer to this photoconductivity ball front face are repeated successively, and a coloring layer is formed in these two or more photoconductivity balls of all.
[0047] After coloring the semi-sphere front face of two or more minute white balls yellow, a Magenta, cyanogen, or black and producing two or more coloring balls by taking the manufacture approach of this example, compared with the case where distribute a coloring ball and a display is produced so that 1 pixel may be constituted from four picture elements on an elastomer sheet, a manufacture process becomes simple.
[0048] (Example 6) Drawing 12 shows the outline configuration of an example using the 1st operation gestalt of this invention of a display. Drawing 12 (a) is a top view and drawing 12 (b) is a sectional view. First, the rubber sheet 2104 which is made to distribute the coloring ball 2103 stated in the example 1, and changes with the transparent lower ITO electrode 2102 on the PET film 2101 with a thickness of 100 micrometers with which the whole surface was covered was formed in 100 micrometers in thickness. The up ITO electrode 2106 stuck the PET film 2105 with a thickness of 100 micrometers which has the transparent up ITO electrode 2106 by which patterning was carried out to the desired configuration on the sheet to apply to said rubber sheet 2104 and the sense which counters by pressure. Although the configuration and size of the up ITO electrode 2106 needed to be chosen according to desired resolution, in order to simplify, by this example, well-known 7 segment type was conventionally used for it. The pulse generator 2107 was connected with each up electrode 2106, peak value 100V and the square wave of 50ms

of pulse width were impressed to all electrodes, and the whole surface was made into the white condition. Next, it checked that the display (a part of figure and alphabet) which the coloring ball 2103 rotated only the part which is equivalent to the selected up ITO electrode when the pulse of reversed polarity is impressed with previously, black-ized, and used the combination of a segment configuration after choosing the thing of arbitration with a switch 2108 among the up ITO electrodes 2106 was possible. Moreover, when the pulse (the first pulse and like-pole nature) of reversed polarity was impressed to the starting black display segment with the previous pulse, it checked that a black display returned to a white display again.

[0049] (Example 7) It changed into the configuration of 7 segment type used in the example 6, and the lower electrode 2112 and the up electrode 2113 consisted of stripe-like ITO electrodes. Stripe-like ITO electrode width of face and its inter-electrode spacing were set to 40 micrometers. The lower electrode 2112 and the up electrode 2113 created the display arranged so that it may intersect perpendicularly mutually. The outline configuration of the display to apply is shown in drawing 13 (a) and 13 (b). Peak value 100V and the square wave of 50ms of pulse width were added to all the lower electrodes 2112 and all the up electrodes 2113 using the non-illustrated pulse generator, and the whole surface was made into the white condition. Next, when the lower electrode 2112 and the up electrode 2113 of arbitration were chosen, the above-mentioned pulse generator was used for inter-electrode [which is built] and the pulse of reversed polarity was impressed, the coloring ball 2103 rotated and black-ized in the field to which two electrodes cross. That is, by choosing the combination of the electrode which carries out pulse impression, it confirmed indicating the desired field by black. Furthermore, with the pulse which brings about a black display, it checked that the amount of black display returned to a white display again by impressing the pulse of reversed polarity.

[0050]

[Effect of the Invention] As explained above, in the indicating equipment which displays when a coloring ball rotates, the cheap minute ball could be used by forming a coloring layer in one semi-sphere front face of said minute ball using a photoconductivity, and it became possible to hold down the price of an indicating equipment low.

[0051] That is, since there is also little effect of an air current like vacuum deposition, it is not necessary to fix a coloring ball. Moreover, the cost of materials was low held down by using a toner cheaper than a vacuum deposition ingredient. Since coloring was furthermore performed in atmospheric air, a tact time is shorter than vacuum deposition, productivity was able to improve, and the price was able to be made cheap by volume efficiency.

[0052] Moreover, the zinc-oxide ball is white and obtained the high display of contrast using this ball.

[0053] Furthermore, the screen was decomposed into two or more picture elements, and each picture element has been colorized simply and cheaply by coloring by the same approach as either yellow, a Magenta, cyanogen and black. Moreover, since the zinc-oxide ball is white, high contrast is shown.

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TECHNICAL FIELD

[Field of the Invention] This invention relates to the manufacture approach of the display which displays by rotating the manufacture approach of a coloring ball, and this coloring ball.

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PRIOR ART

[Description of the Prior Art] In recent years, with development of information machines and equipment, the needs of a low power and a thin display are increasing, and research of the display set by these needs and development are performed briskly. Especially, a liquid crystal display can control the array of a liquid crystal molecule electrically, can change the optical property of liquid crystal, and development active as a display which can respond to the above-mentioned needs is performed, and it is commercialized. However, the burden to the include angle which looks at a screen, and the vision which the alphabetic character on a screen is hard to look at, and is produced from a flicker, low brightness, etc. of the light source by the reflected light is not yet solved fully by the current liquid crystal display. For this reason, research of a new display with few burdens to vision is considered briskly.
[0003] as a new indicating equipment -- N.K -- the indicating equipment which used rotation of the minute ball by electric-field drive by Sheridon and others is proposed ("A twistingBall Display", Proc. of the SID, volume [18th] No. 3/4, 289 - 293 pages, 1977, and a U.S. Pat. No. 4126854 number -- said -- No. 4143103 -- said -- No. 5389945 and JP,64-42683,A). the inside of the cavity which one semi-sphere side of this ball is white, has become black [the semi-sphere side of another side], and formed said ball in the base material using the ball with this minute indicating equipment -- allotting -- the inside of each cavity -- high -- it is filled up with a liquid [****] and a ball enables it to rotate freely in this liquid In this case, the mutual electrification conditions of each semi-sphere part of the black and white of a ball differ, rotation can be controlled by the class of liquid to turn to the side which observes the white or the black semi-sphere side of a ball by giving external electric field, and the target display can be performed.
[0004] Since it is very stable and has memory nature to a temperature change and an electric turbulence noise, while displaying such the mechanical method of presentation, it does not need power. Furthermore, in order to display using reflection and dispersion of the natural light on the front face of a ball, it is the ideal display which can stop the eye strain which happens by flicker of the light source which is seen with liquid crystal equipment and the Braun tube etc.
[0005] By the way, the approach of making a glass bowl contain TiO2 in high concentration, whitening a glass bowl, using a vacuum deposition method for the semi-sphere side of this white glass bowl 41, and forming the insulating black layer 42 by Sheridon mentioned above, as the production approach of the minute ball colored the two color used for the indicating equipment by ball rotation, is proposed (drawing 4).
[0006] Moreover, the two-color ball is formed by the same ("A Newly Developed Electrical Twisting Ball Display", Proc. of the SID, volume [23rd] No. 4, 249 -253 pages, 1982) approach, a vacuum deposition method is used for the semi-sphere side of the glass bowl which whitened, the coincidence vacuum evaporationo of MgF2 and Sb2S3 is carried out, and Saito etc. is forming and classifying the black layer by color. Segregation is carried out and it produces by forming the surface state which consists of a different component so that it may heat-treat on the occasion of whitening of a glass bowl using the glass which consists of LiO2 and three components of TiO2 and SiO2 and light scattering may happen.

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EFFECT OF THE INVENTION

[Effect of the Invention] As explained above, in the indicating equipment which displays when a coloring ball rotates, the cheap minute ball could be used by forming a coloring layer in one semi-sphere front face of said minute ball using a photoconductivity, and it became possible to hold down the price of an indicating equipment low.
[0051] That is, since there is also little effect of an air current like vacuum deposition, it is not necessary to fix a coloring ball. Moreover, the cost of materials was low held down by using a toner cheaper than a vacuum deposition ingredient. Since coloring was furthermore performed in atmospheric air, a tact time is shorter than vacuum deposition, productivity was able to improve, and the price was able to be made cheap by volume efficiency.
[0052] Moreover, the zinc-oxide ball is white and obtained the high display of contrast using this ball.
[0053] Furthermore, the screen was decomposed into two or more picture elements, and each picture element has been colorized simply and cheaply by coloring by the same approach as either yellow, a Magenta, cyanogen and black. Moreover, since the zinc-oxide ball is white, high contrast is shown.

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TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] The approach of two-color-izing of the ball which forms a black layer with vacuum evaporation technique on a white ball as shown in drawing 4 is an approach that production repeatability is high, in using thin film formation. However, in order to form membranes with a vacuum deposition method, there are many processes and productivity is low.
[0008] In order to fix a minute ball in order to prevent a ball soaring according to the air current at the time of vacuum suction and the leak after membrane formation, and to collect the balls after membrane formation, it is necessary to cancel immobilization, and a limit is in the quantity which can be mass-produced in one batch by the reasons of taking time amount to reach the degree of vacuum which can carry out vacuum deposition.
[0009] Therefore, it makes it difficult to produce a coloring minute ball to low cost. For this reason, the technical problem that the ingredient cost of a display was high and could not manufacture the display itself cheaply occurred. When commercializing such an indicating equipment, low cost-ization of a coloring ball was desired.

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MEANS

[Means for Solving the Problem] The indicating equipment of this invention which attains this purpose is an indicating equipment which displays when a minute ball rotates, is forming electrification and exposure, and the coloring ball that carried out the development and colored the semi-sphere front face of a minute ball using a photoconductivity, and becomes possible [coming to hand and producing a coloring minute ball cheaper than vacuum evaporation technique].
[0011] Or using a photoconductivity, electrification and exposure, and after carrying out a development and coloring white one semi-sphere front face of a minute ball, contrast becomes possible [coming to hand and producing a cheap coloring minute ball highly] by forming the coloring ball which colored the semi-sphere front face of another side colors other than white.
[0012] Furthermore, it becomes possible to come to hand and produce a cheaper coloring minute ball by it not being necessary to color white and, if a white zinc-oxide ball is used, and forming electrification and exposure, and the coloring ball that carried out the development and colored only the semi-sphere front face of a minute ball colors other than white using the photoconductivity of a zinc oxide.
[0013]
[Embodiment of the Invention] An example of the drive principle of the display of this invention is explained using drawing 9 . The indicating equipment of this invention consists of an electrode 6 for rotating this coloring ball and making a desired coloring layer side display it as the display medium which consisted of a coloring ball in which the coloring layer was formed, a base material 5 supported for this coloring ball, enabling free rotation, and a cavity 7 for a coloring ball to rotate free, and a driving means which consists of 6' and a power source 8. Moreover, this cavity is filled with the dielectric liquid. The coloring layer 2 just displays a pigmented layer which is different, in view of an observation side by using the color of the reflected light, and the difference of reflectivity. By covering a coloring layer on a minute ball front face, two front faces where optical properties, such as a color of the reflected light and reflectivity, differ are made.
[0014] Moreover, as a configuration of a minute ball, what is necessary is just the thing of a curved-surface configuration like a solid sphere.
[0015] Transfer of a charge is performed between a particle and a liquid, as for the particle in a liquid, an electric double layer is formed, and it is known that a particle will be charged in forward or negative. With the minute ball of this invention, the coloring layer 2 is formed in a semi-sphere front face, and since it has not colored, other semi-sphere sides have the field which consists of two different matter. Therefore, a cation particle or an anion particle carries out specific adsorption to a coloring ball front face from an insulating liquid, and surface potential arises on a coloring ball front face. For this reason, in an insulating liquid, electrification charge properties will differ in each field, and it comes to have the dipole moment in the direction of a pole of a coloring ball. . If electric field are impressed to this coloring ball, on a coloring ball, the torque which is going to arrange that direction of a pole in the direction of electric field will work, and a coloring ball will arrange one of semi-sphere sides with an one direction. Supposing a non-colored field carries out minus electrification and the coloring layer is carrying out plus electrification like drawing 9 , a coloring side will come to the electrode 6 with which minus was

impressed to electrode 6' to which plus was impressed with the power source 8 for the un-coloring side. When this observes the display of this invention from the drawing upper part, a coloring layer (black) can be seen. If the direction of electric field is reversed, it is reversed, and when a photoconductivity ball is a white ingredient, white can be seen [a coloring ball] towards a coloring side observation-side.
[0016] The foreground color according to the polarity of this electrical potential difference can be displayed by operating orthopedically the display medium which consisted of base materials 5 which have the inside of the cavity 7 filled with the coloring ball and the insulating liquid, arranging two or more electrodes to the vertical side of a display medium, and impressing an electrical potential difference to inter-electrode [by which opposite arrangement was carried out], as shown in drawing 10 .
[0017] Although it is possible to use organic solvents and water, such as toluene and an acetone, that what is necessary is just the high liquid of electric insulation as a liquid used for the aforementioned insulating liquid, it is desirable to use the liquid of a non-volatile so that the dielectric liquid which fills a gap may not volatilize. especially -- silicone oil -- the content of ion or an impurity -- low -- high -- it is a liquid [****] and is desirable. Moreover, an insulating liquid contacts a coloring ball, makes the coloring ball front face which has the field which consists of two different matter surface-activity-ize, and has the property which induces two different electrification charge conditions.
[0018] Since advancing side by side of a coloring ball is prevented if possible and it has memory nature as a dimension of cavity 7 **, about [than a coloring ball / somewhat larger] is desirable.

[0019] Moreover, as an electrode used for driving a coloring ball, in view of an observation side, it is required to be light transmission so that the coloring layer formed in the front face of a minute ball can be observed. For this reason, transparence electric conduction film, such as SnO2, TiO2, ZnO, and ITO, is used.
[0020] As a base material (light transmission sheet), in order to display the coloring layer of a minute ball, an optically transparent thing is required and hard resin and silicone rubber, such as polyethylene and polystyrene, glass, etc. are used.
[0021] The indicating equipment of this invention is applicable to the light-receiving mold indicating equipment which displays image information, such as a character, a graphic, and video. Moreover, it can see like paper, and can move like paper, an image can be written in, an image can be copied, an image can be read, and it can apply also to the paper display which can eliminate an image.
[0022] This invention is very good in another operation gestalt. In the 2nd indicating equipment of this invention, the configuration except distributing a coloring ball in the cavity (cavity) formed in the base material (light transmission sheet) with the transparent insulating liquid is taken. The configuration between which only an insulating liquid is made to be placed between coloring balls is taken.
[0023] One example of the 2nd display of this invention is explained using drawing 11 R> 1. As for the coloring ball 1005, the coloring layer is covered by the semi-sphere front face of a photoconductivity ball (not shown). It constitutes from space which closed the space between the 2nd transparence substrate 1004 which carries out phase opposite with the 1st transparence substrate 1002 which has the 1st transparent electrode 1001, and the 1st transparence substrate, and has the 2nd transparent electrode 1003 by the closure section (not shown), and between the coloring balls 1005 in this space is filled up with the insulating liquid 1006. The closed space is filled up with an insulating liquid and the condition that the coloring ball was distributed in the insulating liquid is shown. That is, the configuration which closes the display medium which consists of a coloring ball 1005 and an insulating liquid 1006 with the transparence substrate which has a transparent electrode is taken.
[0024] Furthermore, wavelength fields other than a light wavelength field of the display of this invention are sufficient as the reflected light. For example, the interior of a room can apply the display of this invention also in an infrared light wavelength field.
[0025] Although either an inorganic material or an organic material is OK as an ingredient of a

minute ball as long as there is a photoconductivity, especially a white zinc oxide is desirable. In addition to a zinc oxide, photoconductivity matter, such as a cadmium sulfide, a selenium, silicon, and a copper phthalocyanine, may be used as a main raw material, and spectral sensitization material, binder resin, the charge transportation matter, etc. may be added to this.
[0026] As a dimension of a minute ball, a thing 200 micrometers or less is desirable so that the diameter of a ball may serve as magnitude of 1 pixel or less as a display.
[0027] As an example of the minute ball formation approach of this invention, the zinc oxide solution which grinds and classifies the lump of a zinc oxide as the formation approach of a zinc oxide ball can be breathed out from a nozzle, and it can consider as minute ball shape by the approach of making a solvent evaporate in an instant etc.
[0028] Or a minute polymer ball may be made to distribute the particle of a zinc oxide.
[0029] As the formation approach of a coloring ball, it uses that the above-mentioned minute ball has a photoconductivity, and a minute ball is electrified, it exposes from one side on a minute ball, and a coloring layer is formed in the semi-sphere front face of a minute ball by being developed negatives and established. Each process of electrification, exposure, development, and fixing applies to electrophotography. Electrification can use corona discharge. Exposure can use the light of the wavelength according to the property of a photoconductivity. It is with a coloring toner particle or a magnetic toner, and heat fixing is carried out and carried out, or development can be developed in electrified ink or can also be colored with plating.
[0030] Although development was possible also for any of the positive type with which an umbra is colored, and the negative mold (the so-called reversal development) with which a bright section is colored conversely, drawing 3 showed the example of a negative mold.
[0031] The principle which only the semi-sphere of the minute ball which has a photoconductivity is colored is explained briefly.
[0032] If the insulator layer from which the thickness of a configuration like drawing 6 installed on the conductive substrate differs is electrified, corresponding to thickness, surface potential will become high. Similarly, if a minute ball is electrified on a conductive substrate, the surface potential will not be uniform, the part near a conductive substrate will have low surface potential, and, as for the top-most-vertices section of the furthest ball from a conductive substrate, surface potential will become high.
[0033] If positive development is carried out with the toner of reversed polarity in the state of this dark, toner concentration will change according to surface potential, and it will be colored with [the top-most-vertices section is deep, and the part near a conductive substrate is thin, and] continuous concentration distribution (drawing 7).
[0034] Moreover, when homogeneity exposure is changed into said electrification condition from the ball top-most-vertices section, since the ball is opaque, the ball lower part from which only the upper part of a ball becomes conductivity and serves as a shadow is still high resistance (drawing 8). The surface charge of the ball top-most-vertices section passes through the interior of Ball toward a conductive substrate, and it flows (drawing 8 broken-line arrow head), and it recombines with the electron hole by which the trap was carried out, and surface charge disappears. If reversal development is performed impressing bias voltage for this between a development counter and a conductive substrate using the toner of surface potential and like-pole nature, only the semi-sphere upper part will be colored.
[0035] Moreover, although the electrofax is known as a thing adapting the xerography using a zinc oxide, since it makes a zinc oxide spherical in this invention and the reversible display is conventionally enabled by coloring only the semi-sphere and rotating this, it is an essentially different display system.

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EXAMPLE

[Example] It explains to a detail using an example below.
[0037] (Example 1) Drawing 1 is the sectional view of the minute ball used for the indicating equipment of this invention. Drawing 2 is drawing explaining the color of the minute ball which appears from the observation side when irradiating the natural light 4. A minute ball consists of a photoconductivity ball opaque in a light wavelength field, and the coloring layer is formed in the semi-sphere side. When it sees from an observation side and a minute ball coloring-side turns to an observation side from drawing 2 , the color of a coloring layer will be seen (drawing 2 (a)), and when an un-coloring-minute ball side turns to an observation side, the color of the ground of a photoconductivity ball can be seen (drawing 2 (b)).
[0038] Drawing 3 is the sectional view showing the process of the formation approach of the minute ball of this invention. In this example, the zinc-oxide ball with an average diameter of 50 micrometers was used as a photoconductivity ball 1. The minute ball was sprinkled on the conductive substrate 11 which consists of an aluminum sheet, 2kV corona electrical charging was given to this front face, from the front face, uniform exposure was carried out, the black toner with an average diameter [of LBP-A408 made from canon] of 5 micrometers performed reversal development continuously, and it heated at 180 degrees C, and the toner was fused, it was established (un-illustrating), and the black coloring layer 2 was formed (drawing 3).
[0039] In addition, 350nm ultraviolet rays were used for exposure in consideration of the spectral characteristic of a zinc oxide.
[0040] (Example 2) By the same approach as Sheridon which mentioned this colored minute ball above, it mixed in the elastomer and shaping hardening of this was carried out at the shape of a sheet, by being immersed in silicone oil and making it swell this elastomer sheet, the cavity was formed in the perimeter of each minute ball, and the sheet-like display was produced.
Specifically, said minute ball was distributed in 2 liquid type silicone rubber (Dow Corning sill pot 184). Next, this dispersed system was developed with a thickness of about 100 micrometers in the shape of film on the glass substrate, and heat hardening of this silicone rubber was carried out on 100 degrees C and the conditions of 1 hour. Next, exfoliated the above-mentioned minute ball dispersion hardening rubber sheet from the glass substrate, and it was immersed into the silicone oil (Toshiba Silicone make) of viscosity 1cs for 24 hours, this rubber sheet was made to swell, and the cavity (five to 10 micrometer clearance) was made to form in the perimeter of a minute ball. Next, said rubber sheet was made to pinch with a glass substrate with an ITO electrode layer, and the display was produced. When the electric field of **100V were impressed to this indicating equipment, and a minute ball rotated within a cavity, the semi-sphere side which formed the coloring layer in the observation side according to the polarity of electric field, or the non-formed semi-sphere side appeared. The speed of response was 50 or less ms. When the (+) side came in detail, the minute ball rotated, the semi-sphere side [**** / un-] appeared, and the display became white from the observation side. [of the electric field impressed to the observation side] When the polarity of electric field was changed, the semi-sphere side with a coloring layer appeared, and black was displayed. That is, in the indicating equipment of this invention, the coloring layer was able to be formed only in the semi-sphere side of a white zinc oxide ball, and the display equivalent to the conventional technique was able to be offered

cheaply. Under the present circumstances, the contrast ratio was about 5:1. Moreover, the angle-of-visibility property was **85 degrees or more. That is, in the indicating equipment of this invention, the display equivalent to the coloring ball which formed the two-layer coloring layer only in the semi-sphere side of a transparent glass bowl, and formed the black layer in the white ball of the conventional technique was able to be offered.

[0041] As shown above, it became possible to attain 2 color specification with the indicating equipment of this invention using a minute ball without the process which whitens. The minute ball used for this indicating equipment is easy to be able to use the minute ball of the zinc oxide of the white which can be received cheaply, and for the process colored further to also turn into a process which forms the coloring layer of a desired color only in the semi-sphere side of a minute ball, and to produce the minute ball in which 2 color specification is possible. It became possible to press down the price of a display low by this.

[0042] (Example 3) The 10wt% poly carbo resin THF solution was made to distribute a zinc oxide with an average diameter of 5 micrometers by 10wt(s)% concentration, it applied to the glass-bowl front face with an average diameter of 50 micrometers uniformly, and fixed support of the zinc oxide was carried out into the resin thin film on the front face of a glass bowl. Thereby, a photoconductivity and whitening were able to be performed to coincidence. The same means as an example 1 colored this.

[0043] (Example 4) The minute ball which is not colored [which consists of a zinc oxide ball with an average diameter of 50 micrometers] was mixed in the elastomer by the same approach as an example 2, and shaping hardening of this was carried out at the shape of a sheet. The elastomer sheet was made to swell, charging and exposing, being immersed in the silicone oil which dissolved the black ink which uses Nigrosine as a principal component for this elastomer sheet, and carrying out liquid development of the zinc-oxide ball to this. And it was fixed to 200 degrees C by having carried out heating maintenance for 1 minute, and the black coloring layer was formed. Excessive ink was continuously washed by ink non-added silicone oil, and the minute ball which colored the semi-sphere front face was obtained, and the cavity was formed in the perimeter of a minute ball, and the sheet-like display was produced.

[0044] (Example 5) It exposed carrying out a blue picture element mask in the case of yellow, as it is charged and the elastomer sheet (drawing 5 (a)) was illustrated to drawing 5 (b) in the example 4, and negatives were developed by yellow, the Magenta (Green picture element mask), cyanogen (red picture element mask), and the silicone oil that dissolved the ink of one color among black (ND picture element mask = mask which has flat absorption in a visible region).

[0045] Exchanging or moving a picture element mask, this processing was performed about each color, yellow, a Magenta, cyanogen, and four black picture elements were formed, and one pixel consisted of these four picture elements (drawing 5 (c)). An image consists of two or more pixels. The image of a color is displayed by choosing each picture element of each pixel as white, yellow, a Magenta, cyanogen, or black.

[0046] That is, the process which makes a light transmission sheet distribute two or more photoconductivity balls in this example, The electrification process which electrifies these two or more photoconductivity balls, and the process which chooses some photoconductivity balls in these two or more photoconductivity balls with a mask, On the bright section front face of the photoconductivity ball with which it dipped in the exposure process of the selected photoconductivity ball which irradiates light on a front face, and the insulating liquid which has a charge of a coloring matter, and light was irradiated, in part Yellow, A Magenta, cyanogen, the development process that any one electrified charge of a coloring matter is made to adhere among blacks, and forms a coloring layer, and the fixing process which fixes this coloring layer to this photoconductivity ball front face are repeated successively, and a coloring layer is formed in these two or more photoconductivity balls of all.

[0047] After coloring the semi-sphere front face of two or more minute white balls yellow, a Magenta, cyanogen, or black and producing two or more coloring balls by taking the manufacture approach of this example, compared with the case where distribute a coloring ball and a display is produced so that 1 pixel may be constituted from four picture elements on an elastomer sheet, a manufacture process becomes simple.

[0048] (Example 6) Drawing 12 shows the outline configuration of an example using the 1st operation gestalt of this invention of a display. Drawing 12 (a) is a top view and drawing 12 (b) is a sectional view. First, the rubber sheet 2104 which is made to distribute the coloring ball 2103 stated in the example 1, and changes with the transparent lower ITO electrode 2102 on the PET film 2101 with a thickness of 100 micrometers with which the whole surface was covered was formed in 100 micrometers in thickness. The up ITO electrode 2106 stuck the PET film 2105 with a thickness of 100 micrometers which has the transparent up ITO electrode 2106 by which patterning was carried out to the desired configuration on the sheet to apply to said rubber sheet 2104 and the sense which counters by pressure. Although the configuration and size of the up ITO electrode 2106 needed to be chosen according to desired resolution, in order to simplify, by this example, well-known 7 segment type was conventionally used for it. The pulse generator 2107 was connected with each up electrode 2106, peak value 100V and the square wave of 50ms of pulse width were impressed to all electrodes, and the whole surface was made into the white condition. Next, it checked that the display (a part of figure and alphabet) which the coloring ball 2103 rotated only the part which is equivalent to the selected up ITO electrode when the pulse of reversed polarity is impressed with previously, black-ized, and used the combination of a segment configuration after choosing the thing of arbitration with a switch 2108 among the up ITO electrodes 2106 was possible. Moreover, when the pulse (the first pulse and like-pole nature) of reversed polarity was impressed to the starting black display segment with the previous pulse, it checked that a black display returned to a white display again.
[0049] (Example 7) It changed into the configuration of 7 segment type used in the example 6, and the lower electrode 2112 and the up electrode 2113 consisted of stripe-like ITO electrodes. Stripe-like ITO electrode width of face and its inter-electrode spacing were set to 40 micrometers. The lower electrode 2112 and the up electrode 2113 created the display arranged so that it may intersect perpendicularly mutually. The outline configuration of the display to apply is shown in drawing 13 (a) and 13 (b). Peak value 100V and the square wave of 50ms of pulse width were added to all the lower electrodes 2112 and all the up electrodes 2113 using the non-illustrated pulse generator, and the whole surface was made into the white condition. Next, when the lower electrode 2112 and the up electrode 2113 of arbitration were chosen, the above-mentioned pulse generator was used for inter-electrode [which is built] and the pulse of reversed polarity was impressed, the coloring ball 2103 rotated and black-ized in the field to which two electrodes cross. That is, by choosing the combination of the electrode which carries out pulse impression, it confirmed indicating the desired field by black. Furthermore, with the pulse which brings about a black display, it checked that the amount of black display returned to a white display again by impressing the pulse of reversed polarity.

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the sectional view of the coloring ball used for the 1st indicating equipment of this invention.
[Drawing 2] It is drawing explaining the foreground color of the coloring ball which appears from the observation side of the 1st example of this invention.
[Drawing 3] It is drawing showing the formation process of the coloring ball of the 1st example of this invention.
[Drawing 4] It is a sectional view explaining the coloring ball of the conventional example.
[Drawing 5] It is an example of the result doubled in the sheet, the mask, and 4 **** in the case of colorizing.
[Drawing 6] It is drawing explaining electrification potential.
[Drawing 7] It is an example at the time of carrying out positive development at the time of dark.
[Drawing 8] It is drawing showing the example at the time of exposing and carrying out reversal development from ball top-most vertices.
[Drawing 9] It is drawing showing the principle of the display of this invention.
[Drawing 10] It is drawing showing the display of this invention.
[Drawing 11] It is drawing showing the 2nd display of this invention.
[Drawing 12] It is drawing showing the display used for the example 6 of this invention.
[Drawing 13] It is drawing showing the display used for the example 7 of this invention.
[Description of Notations]
1 Photoconductivity Ball
2 Coloring Layer
4 Natural Light
31 Substrate
32 Electrification Machine
33 Exposure
34 Development Counter
41 White Glass Bowl
42 Black Layer
51 Sheet Which Distributed Photoconductivity Ball Uniformly
52 Exposure Mask for Y (Yellow)
53 Picture Element and Pixel Which were Exposed and Developed with Y, M, C, and Each Exposure Mask for Bk

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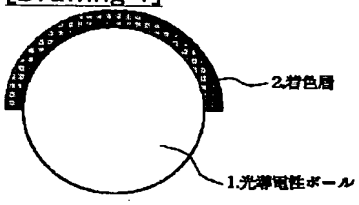
[Translation done.]

* NOTICES *

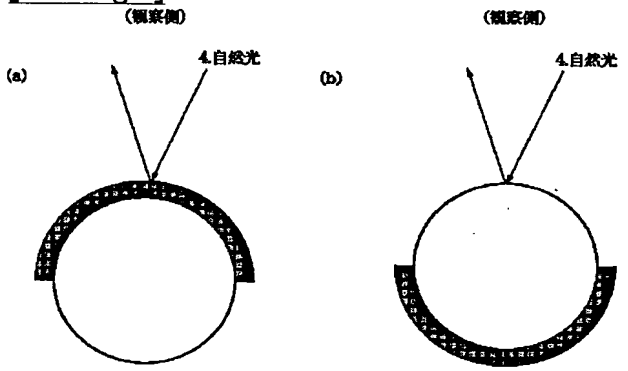
1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

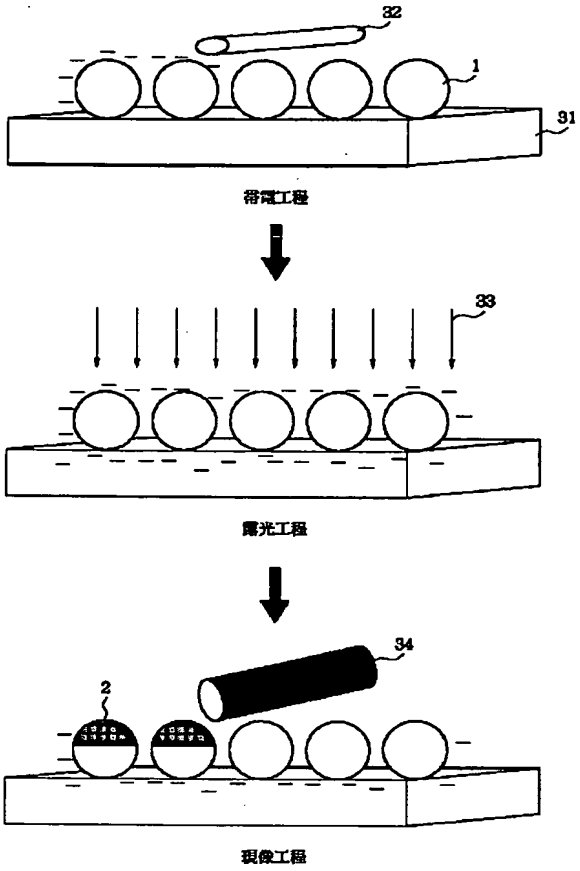
[Drawing 1]



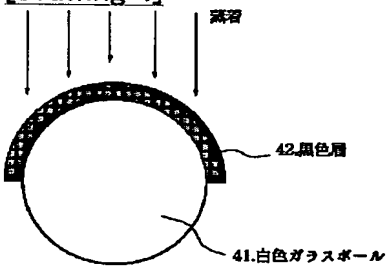
[Drawing 2]



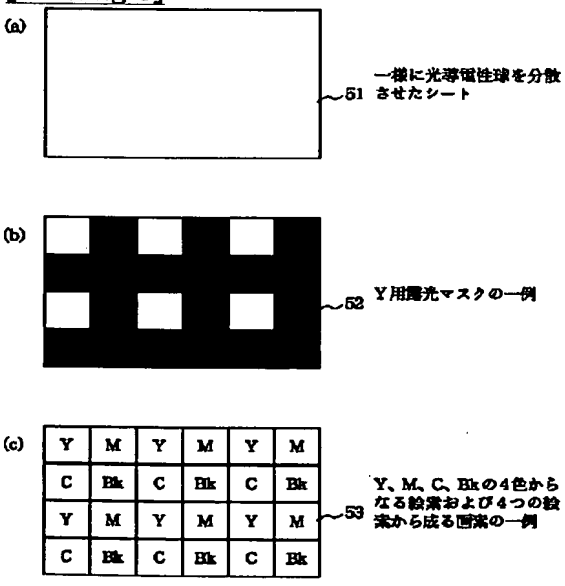
[Drawing 3]



[Drawing 4]



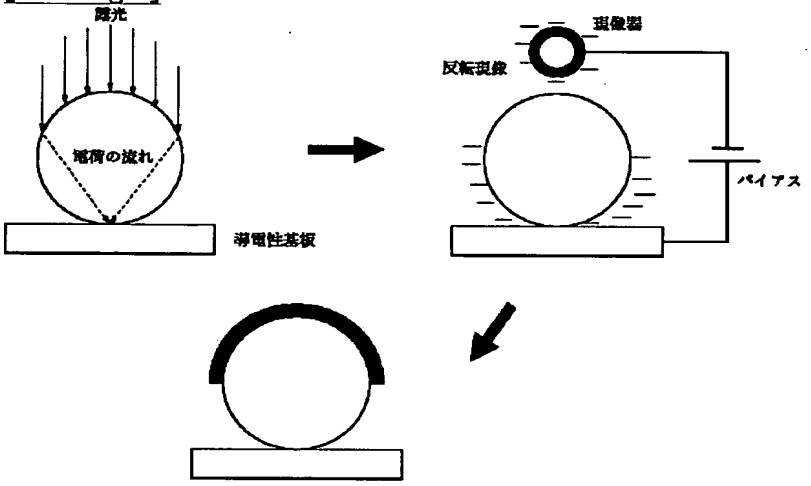
[Drawing 5]



[Drawing 6]

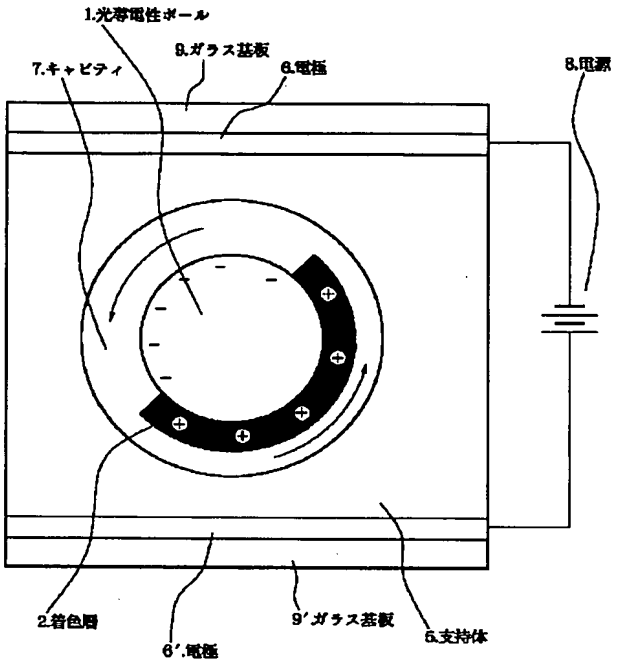
[Drawing 7]

[Drawing 8]

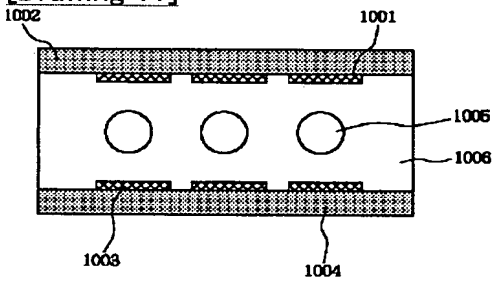


[Drawing 9]

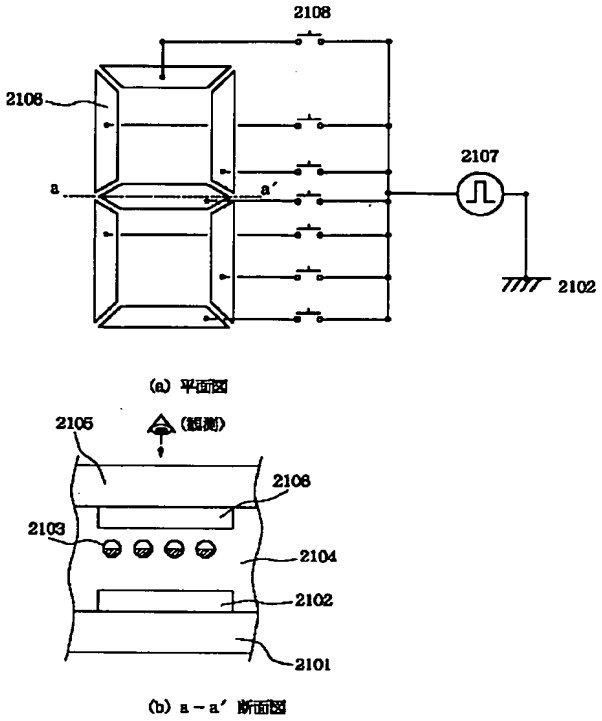
(視察側)



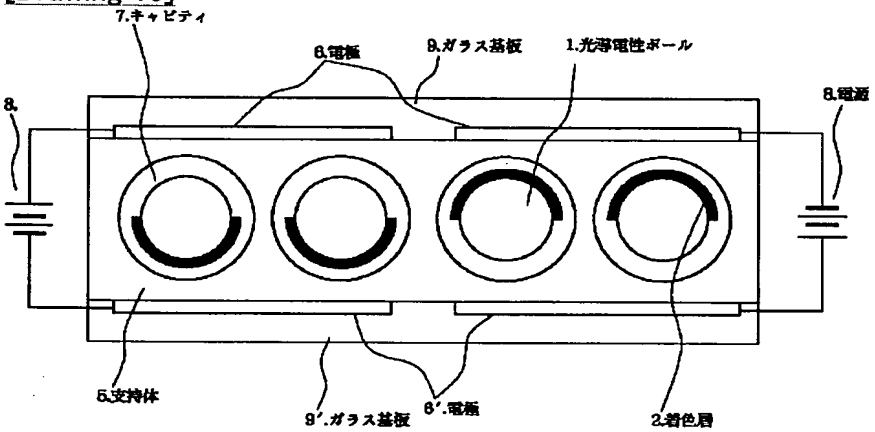
[Drawing 11]



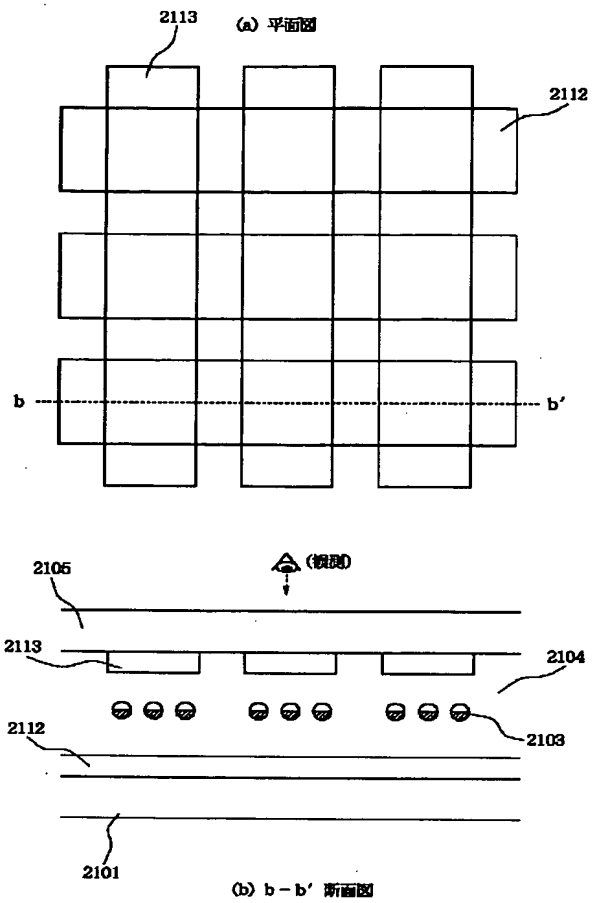
[Drawing 12]



[Drawing 10]



[Drawing 13]



[Translation done.]